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Development of Solar Powered Atmospheric Water Generation and Purification System

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Abstract- In world the several countries are facing problem that to find a water resources for irrigations and etc., more in arid areas. the lack of downfall is causing water insufficiency around the world. If we consider a coastal area we can find sea/ocean but there is problem of drinking water and the such regions has high moisture air. The paper research development of such device that could able to produce water by compressing moisture air the water by the help of thermoelectric device. The device mainly consists of condensing block for condensing the moisture air and inlet fans for sucking air into system and solar powered battery and external supply for to drive the system. And last but not least the whole system is controlled by the Arduino Uno.
hardware used: Arduino Uno
software used: Arduino IDE, Proteus
keywords- condensing block, Peltier module, solar powered battery.

I. INTRODUCTION

Any kind of life is impossible without water. There is no life without water on this planet. Out of the total surface area of the earth, 71% is covered with water and only 2.5% of it is freshwater which can be used for drinking. Without proper access to clean drinking water, dehydration and many waters borne diseases are taking a toll on people's health. As the human body is made up of 70% of water, dehydration can result in death. The air in the atmosphere contains water in the form of vapour moisture which can be expressed in the form of relative humidity. For instance, if we say 60% humidity at 200C, one kiloliter of air will contain about 10gms of water. This water within the atmospheric air can be extracted by implementing a tool like an atmospheric water generator and may effectively use solar power. A Conventional condensation atmospheric water generator uses vapour compression refrigeration and moves the filtered air over the evaporator coil using a fan. Due to this the temperature of the air falls below the dew point and therefore the water vapour condenses into droplets of water. These sorts of atmospheric water generators produce drinking quality water but are bulky and use more electricity. In the past few years, some projects have been done to generate water using Peltier devices, like harvesting water for young plants using Peltier devices that are powered by solar power, etc. A Peltier module is a thermo-electric semiconductor device that can be used to condense the water vapor in the atmosphere.

Dehumidification techniques

The common methods of dehumidification of air are;
refrigeration condensing,
pressure condensing,
bringing the temperature below dew point.
Using these techniques, the moisture in the air can be condensed to generate clean drinking water

II. Literature survey

There are a lot of previous studies and research on this project. Not all of the papers concentrate on low-cost and reliable systems. Below are the few papers we have referred to regarding this project.

Experimental Study and Performance Analysis of a Portable Atmospheric Water Generator This paper demonstrates the design of transportable water generator based on thermo-electric Peltier to maximize the water generation. Thanks to its simple structure and compact structure, this portable water generator can be greatly useful for hikers, expeditions, cyclists and scientific investigation teams. The cold side of the model was designed using hydrophobic material. This hydrophobic material increased the condensation rate of air near the cold side of the Peltier. Also, the discharged cool air was passed through the hot side to cool the hot side of the Peltier using latent heat principle. This reusing of cooling energy to remove more heat energy from the hot side maximized the water yield theoretically with minimal energy consumption. Considering all the operating conditions, it was found that the water generation rate increased with the increase in the relative humidity of the air and airflow rates.

A Project on Atmospheric Water Generator with the Concept of Peltier Effect.

The model proposed a model that could generate almost 1 Liter of water per hour using a thermo-electric Peltier device during the daytime when applied in a highly humid region. It proposes a design which uses high power solar cells and also stores the surplus energy in the daylight that can be used in the night. The concept of this project was to provide a better alternative to conventional systems which uses low power semiconductor devices to optimize power consumption of refrigeration science and to improve the refrigeration science.

Solar Powered Atmospheric Water Generator and overview on AWG technologies. By applying devices aside from a standard evaporating principal device, we can extract a good amount of water from the atmosphere. Use of solar power by way of Solar PV or Solar Heating, these devices are not only energy efficient but can also be used as standalone systems where electricity or other sorts of energy isn't readily available. The design of devices is comparatively simple and may be carried to places like hilly areas, arid regions, flood areas, etc. In the current climate with global warming threat and therefore the water resources over the world vanishing, these solar integrated devices are often extremely useful. With the advances within the technology of those devices resulting in more enhanced & efficient systems, such AWG systems hold a bright future for a generation of much-needed water.

Solar-Powered Atmospheric Water Generation and Purification System. The system setup done in this research is yet to be optimized. the various system parts comprising the entire Solar Powered Atmospheric Water Generation and Purification System (SAWGAPS) are found to be workable. The inverter has successfully lighted a 160-watt mercury bulb. There's an excellent possibility that it can power a kilowatt load and may be used not only with grid electricity but also with a solar energy source. The purification system has been proven to purify water that meets the standards for drinkable water. The water generator, made up of car AC parts, has generated an amount of water enough to provide a daily household's drinking needs. During its initial run, it had been ready to generate 18 liters of water during a day.

The Development of Solar-Powered Atmospheric Drinking Generator with Charging Bay The system setup in this paper was able to produce an average of 23.30 liters of water in 24 hours and consumed power at an average of 150 Watts in ideal conditions. The water generated was tested in the laboratory; the optimal total coliform was found to be less than 1.1, the coliform. A UV filter was used to ensure better safety of water. The researchers have determined that it is a practical method of water generation. The results show that the efficiency of water generation is dependent on the air. where it is placed. The charging bay which was developed was able to charge the gadgets as fast as a conventional charger which uses AC power. This paper recommends determining the best location for the model to increase the efficiency of water generation.

III. Methodology

The warmer the air, the more water vapor it can hold. The moisture air is pumped first into the tube thus the cold side of the Peltier element helps to decrease the air temperature. So, as the air cools down, its capacity of holding water decreases, and water moisture starts condensing. The air is then passed through to the hotter side of TEC that cools the temperature of the hot side, as shown in the above diagram. This is necessary to keep running the Peltier device otherwise, the temperature will increase on the hot side so much that the device could be damaged. This warm air can be sent to the cooler side to increase the water generation, as described earlier. The condensed water falls into a reservoir then passes through a filter. To maximize energy generation from the sun, it is necessary to introduce solar tracking systems for tracking sun rays and face the solar panel in various directions to properly face the direction of the Sun. This system is controlled by Arduino Uno, consists of servo motors, a raindrop sensor, temperature and humidity sensor, and LCD for monitoring the weather conditions. We use LDR Sensors to track the intensity of the light to locate the direction of the sun, then the Arduino Uno calculates & controls the position of the motor. This is routed to charge a battery and then the DC battery is used to power an AC load using an inverter, all of which is digitally controlled & tracked using the Arduino Uno & displayed on the LCD. Our solar panel is used to constantly charge the battery using charge controller circuitry. And once we turn on the load switch the battery charge is inverted and stepped up from battery to around 140 – 150 V AC. This is mainly used for air to water Generators & Purification, with various applications such as Solar Water Heater, Solar home lighting, etc

IV. OJECTIVES OF THE PROJECT WORK

- To effectively utilize natural energy resources and optimize using this technology.
- To generate water from the humidity present in the air.
- To filter the water and purify it.

V. DEVELOPMENT OF PROPOSED MODEL

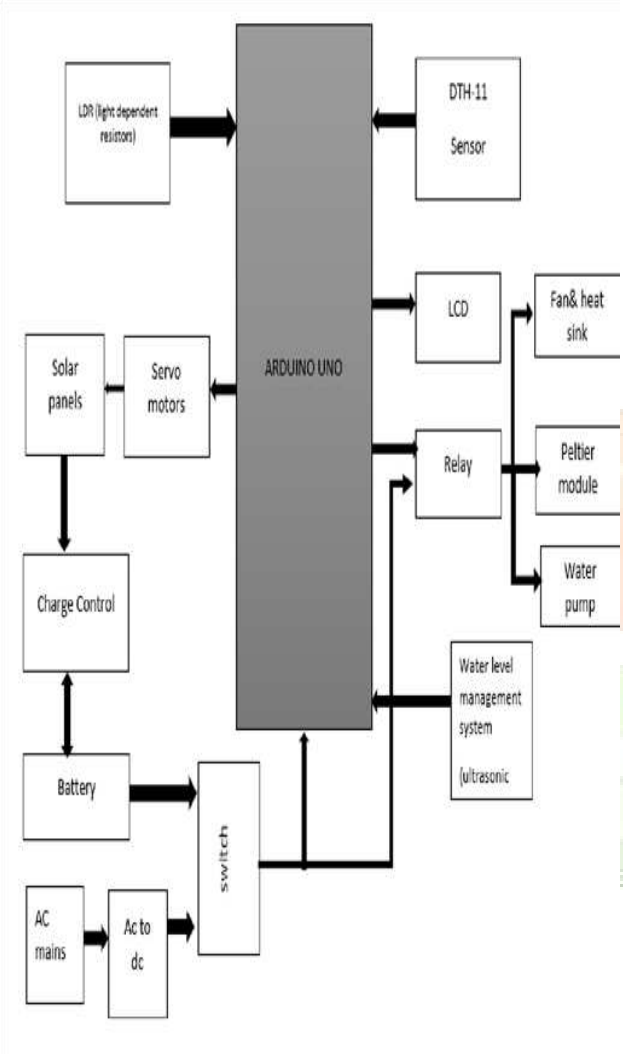


Fig.1: Block diagram

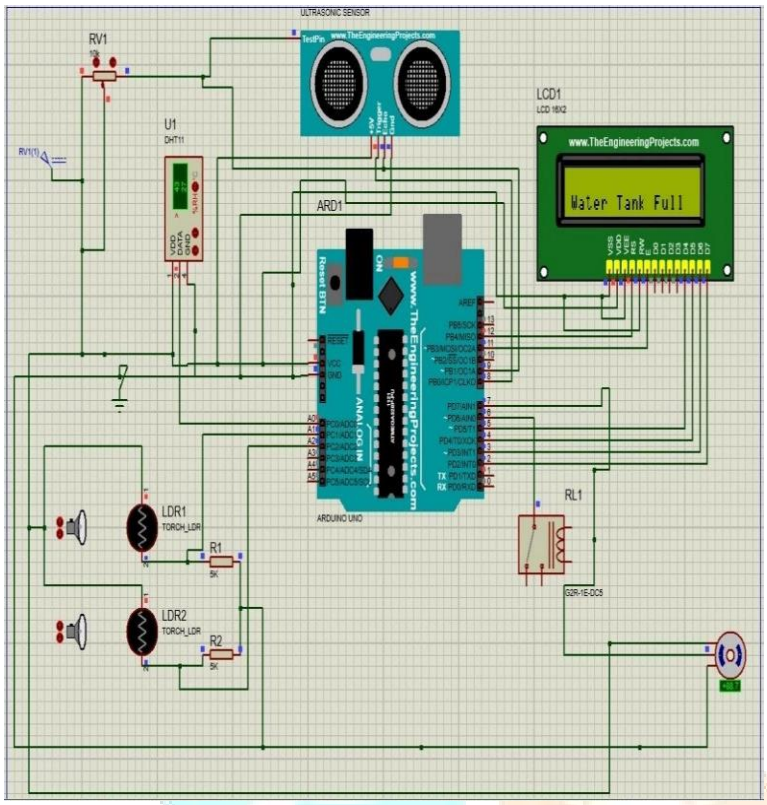
Solar UPS & Consumption

- To maximize the energy generation from the sun, the solar tracking system is used, which tracks the sun rays and alters the angle of the solar panel in various directions to properly face the sun's direction.
- The system is controlled by Arduino Uno, which consists of a servo motor, LDR sensor, humidity and temperature sensor, and LCD display to display the humidity and temperature.
- LDR Sensors are used to track the intensity of the light to locate the sun's direction, then the Arduino Uno calculates & controls the position of the servo motor.
- The output of the solar panel is connected to the charge controller to charge the battery and, at the same time, provides the source for the AWG system.
- The energy stored in the battery can also be used for external appliances

Air to Water Generator

An atmospheric water generator is a device that uses the humid ambient air present in the surroundings of the AWG system. Water vapour in the Air is extracted by condensing it. Condensing is done by cooling the air below its dew point. The Arduino Uno is responsible for automating the system.

- If the data captured by the humidity sensor seems appropriate for the process to continue, the processor turns on the inlet Fan to force the Air. into the system.
- A thermoelectric Peltier module is used to cool down & condense the pulled in atmospheric Air with the help of hollow copper tubes to form water vapour droplets being formed.
- This is the same effect that occurs in the refrigerator, which leads to water being collected down in the bottom tray. So, the very same phenomenon that occurs as a by-product of the refrigerator's cooling system here in our project is converting water from the Air's humidity.
- Further, this water is collected and directed into a holding tank after filtration. Here the water levels & water quality levels are monitored.



VI. RESULT AND DISCUSSION

This section discusses the simulation and hardware results and performance analysis of the proposed Solar-powered Atmospheric water generation and purification system.

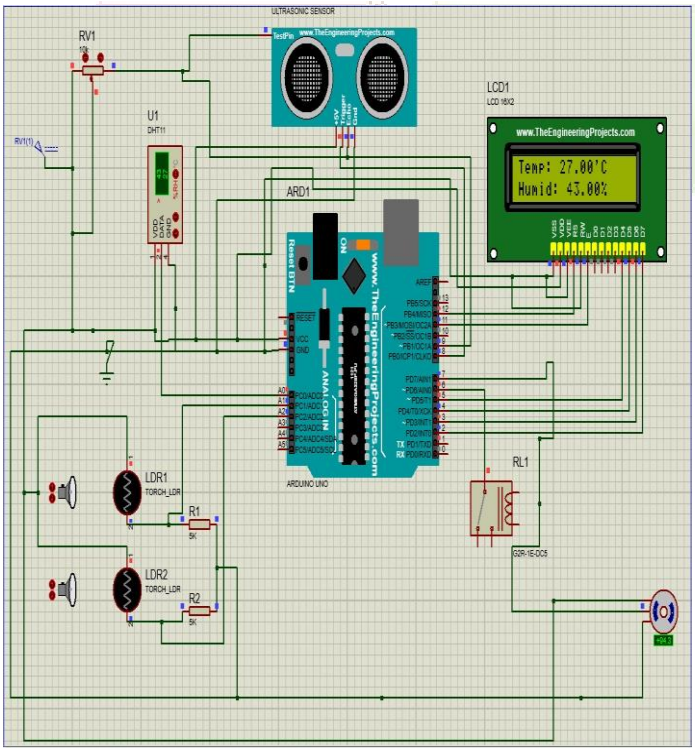


Fig.2: schematic diagram of the proposed system

The above fig2 shows the schematic diagram of the proposed system and fig4 shows the output result. The system will monitor the sensor outputs and controls the system. For solar tracking, the Arduino Uno (A1, A2) are LDR output voltages that are compared and rotates the servo motor(5v) towards the sun's direction. For AWG system consists of the LCD (16X2), relay(5v), DHT sensor(5v) that will measure the humidity and temperature of the surrounding environment and transfer the data to Arduino Uno, which will display humidity and temperature accordingly and also compares the humidity (if humidity level falls less the 20% the AWG system will be turned off by stopping the relay command(pin6) or less continues process). For water level management the ultrasonic sensor(5v) will send a continuous signal through the trigger pin and accept the echo signal through the echo pin and this will be fed to Arduino Uno, which will measure the level of water (if the level of water less than 1cm this the AWG system will turn off by stopping command signal to relay). The result of water level is shown in bellow fig.3.

Fig.3: simulation output

Fig.4: Hardware arrangements of the proposed system

AWG system results: In the system, The Peltier module's cold side is attached to the water block and the Heat sink to the hot side to prevent the module from overheating. The system consists of Inlet Fans to force the surrounding into the system, this air is condensed by the help of cold copper tube, such process helps to generate water, The output results are shown in below figure 5.

Fig.5: AWG system and water level control module

Fig. 4 shows the arrangement of components and proposed model. The upper part will produce water which then gets purified and is fed down to the holding tank where the ultrasonic sensor will monitor the water level. if the water level is more than 1cm far from the sensor it will continue its operation if the water level is less than 1cm the AWG system is turned off.

Fig.6: AWG system when power is given

Fig.7: AWG system (generated water droplets)

Fig.5 shows the complete output results of the system, when 12v is supplied to the Peltier, it starts conducting (that is one side gets hot and another side cold) and the coldness pf the

Peltier module will be transferred by water block and water pump (6v) to the cold copper tube on which air is condensed into water droplets and the generated water is purified by the UF membrane filter and then stored in the tank.

As we ran the system, we were able to produce approximately 1L of water in about 4.3 hours. The time per liter of water generated can be reduced by scaling up the model.

The temperature and humidity are the main parameters for water generation, water vapor is available in the air but this can be varied based on the temperature and humidity parameters. The hot air can hold a greater number of water vapors, this air is inlet through the inlet Fans then it is condensed by a copper tube which is connected to water block; hence the air becomes cooler and it loses its holding capacity hence there is generation of water droplets. This water then passes through a small filter that can purify it. There is a closed-loop formed by monitoring inlet air and outlet air and also temperature and humidity.

VII. CONCLUSION AND FUTURE WORK

The project solves the issues of the water by extracting the moisture within the air (dehumidification), further condensing & filtering the water all of which is powered & operated with a solar-powered UPS Setup which reduces the power outage problem.

This system is able to produce one liter of water in four and a half hours during daylight in high humidity areas and the system can charge the battery by itself because the system has solar power which helps the system to operate during night-time and it also has a support of external supply. We saw that the larger system always has a high-end purifier (RO and UV filter) that can provide the purified water which can match the standards

of WHO and BIS. The best Peltier module TEC1 in its various models. In this system for filtering the air, we aren't using large scrubbers which are more effective in an air filter in their types and used in large size systems.

The future work of the project is designing a system in such a way it could generate water in large quantity and with less power consumption. For now, we have taken support of an external supply and which can be removed and the solar-powered battery runs the whole system.

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