Chapter 22
Development of an Atmospheric Drinking Water Generator

Suhaimi Bahisham Yusoff and Muhammad Amirul Rafizat

Abstract Some communities have difficulties accessing clean water sources because of a lack of water supply facilities especially in rural areas and during disasters such as droughts and floods. Thus, the atmospheric drinking water generator is proposed to overcome this problem by providing a system that can convert air into safe drinking water. This atmospheric drinking water generator uses the principle of condensation of air, cooled to its dew point, and becomes so saturated with water vapor that it can no longer hold the liquid. Peltier or thermoelectric cooler (TEC) is used as a condensation process medium to cool the air to the dew point. Water that has been converted from the air is collected in a collector tank. When the collection tank is full of water, water will be pumped out through a filter set to remove possible bacteria and add minerals to the water. The proposed system with a condenser size of 4.5 cm × 4 cm × 2 cm can produce 6–9 ml of water per hour depending on surrounding conditions. To increase the amount of water converted from the air, the size of the condenser used needs to be enlarged to increase the surface area of the condensation process.

Keywords Thermoelectric cooler · Atmospheric water generator · Peltier effect

22.1 Introduction

Water is very important for human life, water is the source of life. With the water resources available on earth, human beings can live in a prosperous way to enable us to carry out activities well. But not all communities in the world have access to clean water. Some communities find it difficult to get clean water supply due to the lack of water supply facilities such as the rural population [1]. The government has spent

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millions of moneys to implement infrastructure projects to supply clean water to the rural population. However, there are still communities that still do not have access to clean water. In addition, natural disasters can also affect water supply problems such as drought and prolonged floods in the country which can make water supply difficult for the community.

To overcome this problem, a system that can convert water from the air has been introduced. Several projects have been implemented to produce systems that can convert air into water [2–6]. To convert air into water, the temperature needs to be lowered to reach the dew point and there are several steps and ways to do this [2]. Several projects have used a microcontroller as a controller circuit, the fan serves as air to let air enter the condenser and through a coil that has been cooled using TEC [2–6]. Once the water is formed, the water will be collected in a storage tank after going through the filtration process. Suryaningsih and Nurhilal [2] had proposed a system consists of a PWM controller circuit, air fan, an array of Peltier modules, the hot side channel as radiator, blade valve, and condenser. The TEC module will remove heat from the air flowing along the cold side channel and push this heat in the hot side channel of the module. The humid air source is required to supply the cold side channel for condensation process. Tripathi et al. [3] had proposed to convert air into water by using a compressor, and then the air is passed through a condenser pipe which lowers the temperature to the dew point. The water is then filtered through several filter such as carbon, reverse osmosis, and UV sterilization lights. Nitheesh et al. [4] had developed a water condensation system based on thermoelectric cooler. The system consists of cooling elements, heat exchange unit, and air circulation unit. A solar cell panel unit with a relevant high current output drives the cooling elements through a controlling circuit. It uses the principle of latent heat to convert water vapor into water droplets.

Nandy et al. [5] had developed a system based on a thermoelectric cooler. The developed system consists of cooling elements, heat exchange, air circulation, TEC couple, conventional compressor, and evaporator system be used to condense water by simply exchanging the latent heat of coolant inside the evaporator. Ramya et al. [6] had proposed a system consisting of cooling elements, heat exchange unit, air circulation unit, pH sensor, conductor with fan, and Arduino Uno. They have used a Peltier which is portable and eco-friendly to create the atmospheric water generator. Using dehydration tactics will be more expensive and not portable, so they generate water from the air using Peltier tools at a lower cost and efficient in terms of the amount of water collected and easy to carry.

In this paper, we have developed the atmospheric drinking water generator which will convert the air into water by using the principle of condensation. The idea of this project is to help the community to get clean water supply for those living in the rural area and during natural disasters that cause the clean water supply is disrupted. The system to convert the air into water is proposed by using a microprocessor-based system which consists of Peltier or TEC that has been used as a condensation process medium, cooler, etc. The rest of the paper is organized as follows. Section 22.2 gives a detailed explanation of the proposed system. Section 22.3 presents the experiment results for the proposed system with discussion. Section 22.4 concludes with a summary of the proposed system and discusses the future works.

22.2 Methodology

The main purpose of this project is to convert air into water using a condensation process. Theoretically, there will be water droplets through the condensation process but it has some problems. For example, if the temperature is too cold, water droplets will freeze and if the temperature is not cold enough, water droplets will not form. So, a suitable temperature is required to produce water droplets from the air. This project uses the principle of air condensation, cooled to its dew point, and becoming so saturated with water vapor that it can no longer hold liquids. Peltier or TEC is used as a condensation process medium to cool the air to the dew point. The water that has been converted from air accumulates in the collector tank.

Figure 22.1 shows the design of the proposed atmospheric drinking water generator. The condenser functions as an air to water conversion medium where the condenser requires the cooler to allow temperatures in the condenser to be lower than the incoming air temperature. The incoming and outgoing air are controlled using fans that act as an air sucker. Once the incoming air is converted into water droplets, the water formed will be collected in the first water storage tank until full. Once the first water storage tank is full of water, it will be transferred and filtered to the second tank. Minerals have also been added for health benefits. Upon completion

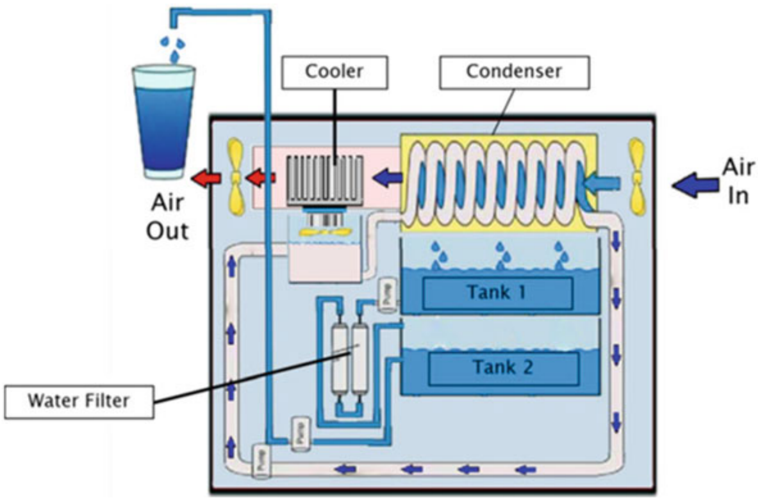

Fig. 22.1 Design of the atmospheric drinking water generator

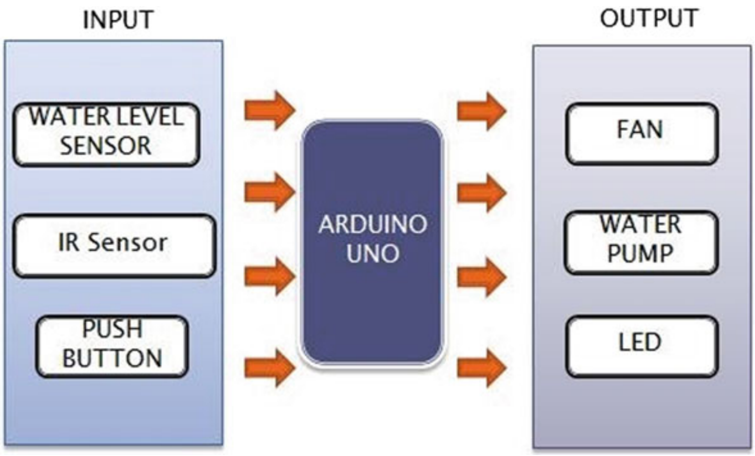

Fig. 22.2 Block diagram

of the filtration process, the water will be stored in a second tank to allow the water to be used safely.

Figure 22.2 shows the block diagram of the proposed system. The proposed atmospheric water generator system is operated by a microcontroller. The project requires sensors to act as inputs that detect system changes and functional outputs relying on input detection. Water converted from the atmosphere will be collected in tank 1. When the water in the first tank is full, the water pump will turn on. The water pump in tank 1 will operate until the water level sensor in tank 2 reached the desired level. The water pumped to tank 2 will pass through a filter before going to tank 1. When the water level sensor in tank 2 detects water at the desired level, the water pump in will be turned off and the green LED will turn on to indicate the tank is full of water. The system will continue to convert the air to water until both tank 1 and tank 2 are full. If both tanks are full, the condenser will turn off to stop converting the air to water. The water in tank 2 has already gone through a process of filtration and mineral addition for health.

Figure 22.3 shows the system flowchart detailing the operation of the proposed system. The water level sensor will control the condenser, water pump 1, and LEDs to turn on and off. The IR sensor will operate to turn the operation of the water pump 2. Figure 22.4 shows the system circuit diagram and the connection of each component. Figure 22.5 shows the prototype design of the atmospheric water generator.

22.3 Results and Discussion

A prototype has been developed for this project. The prototype designs are produced in sizes that are not too large to allow the project to be moved easily without having

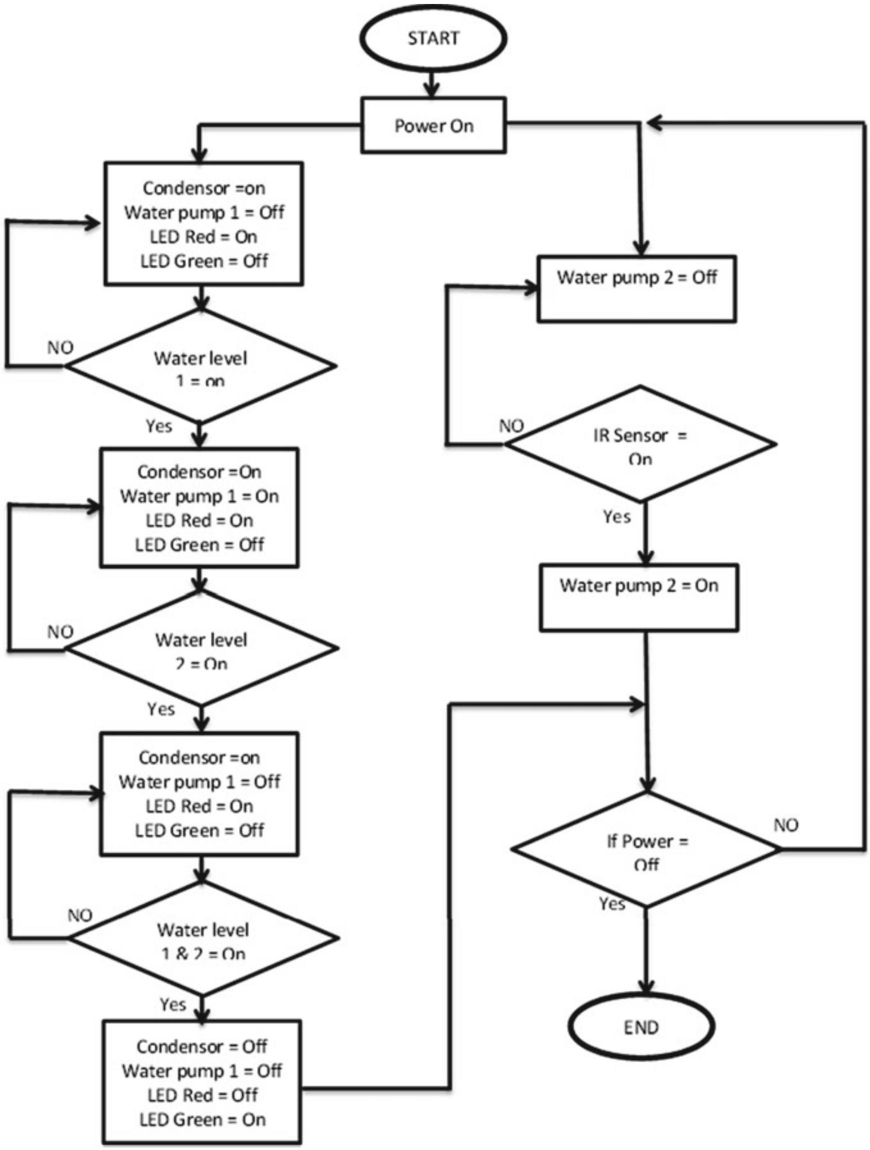

Fig. 22.3 Flowchart of system

to use a lot of energy. In addition, it is also designed without the need to add additional features to the tap water source. Figure 22.6 shows the prototype atmospheric drinking water generator developed in this project, while Fig. 22.7 shows the arrangement of the important parts found in the project, namely condenser, storage tank, coolant, fan, filter, and water pump.

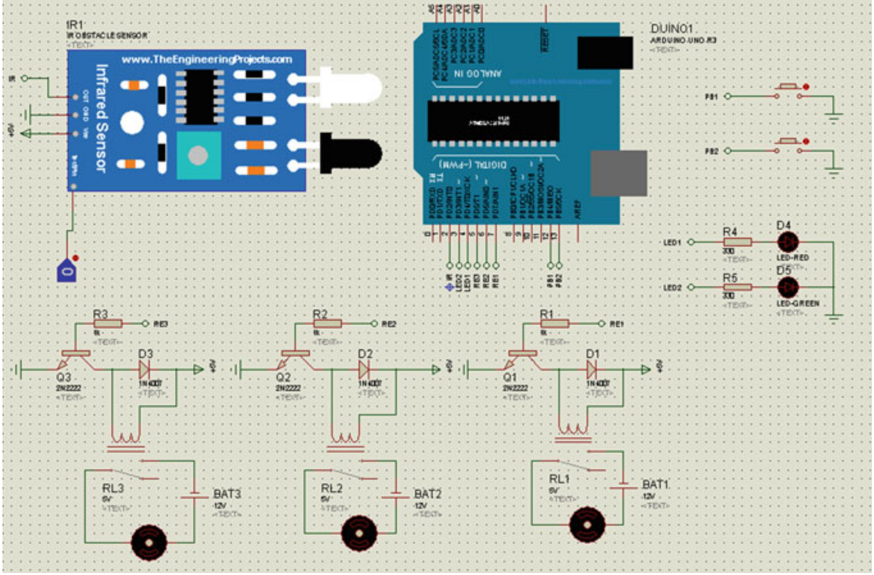

Fig. 22.4 Circuit diagram for the atmospheric drinking water generator

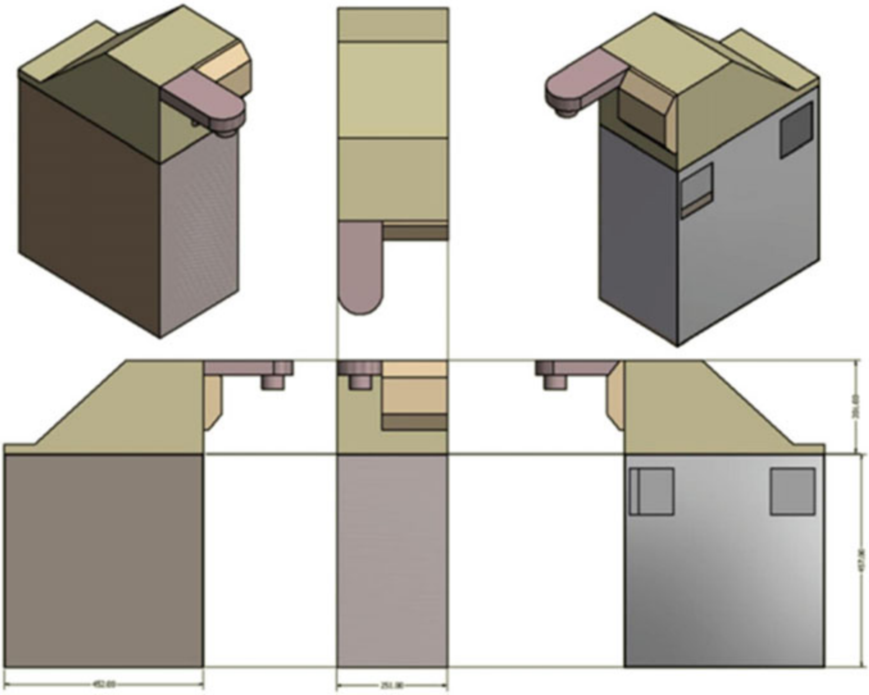

Fig. 22.5 Prototype design of the atmospheric water generator

Fig. 22.6 Prototype of atmospheric drinking water generator

Fig. 22.7 Internal view of the prototype

Figure 22.7 shows the three main parts of the system, namely tank 1, tank 2, and condenser. The condenser is the part that does the process of converting air into water by removing the heat from the air. Once water is formed, the water will be collected in tank 1. The water will be collected until the sensor detects water at a certain level. When the water reaches the setting level and the sensor detects the water, the controller will turn on the pump and pump the water out of tank 1 to tank 2. The water will be stored in tank 2 for drinking purpose.

For the process of dispensing the water for drinking, the user needs to place a glass in front of the IR sensor under the dispenser host and the water will be poured into the glass for drinking. When the IR sensor detects the glass in the dispenser, it will send information to the processor to activate the water pump in tank 2. The purpose of pump 2 is to dispense water from tank 2 that has been purified and safe to drink. The level sensor functions to detect the water level. It works when 0 indicates, the sensor detects there is water, while 1 means the level sensor does not detect water. The sensor operates that way because the sensor is connected to ground. The level sensor 1 and the level sensor 2 work to turn on the pump 1 and the condenser if the level sensor 1 is equal to 0 and the pump 1 is turned on (1). Pump 1 will be turned on until the level sensor 2 is 0. Otherwise, pump 1 continues to operate. If all sensor levels are 0, the condenser and pump 1 will be turned off (0). Table 22.1 summarizes the operations for the project.

The size of the condenser used for this prototype is 4 cm × 4.5 cm × 2 cm. The proposed system with the condenser size can produce 6 ml to 9 ml of water per hour. Figure 22.8 shows the graph of the water produced from the system. The test period is from 9:00 a.m. to 8:00 p.m. For each hour, the produced water is measured. The average amount of water produced per hour is around 7 ml. Water output is determined by the surface size of the condenser, the temperature produced by the condenser and the humidity level of the air at that time. To increase the amount of water converted from the air, the size of the condenser used needs to be enlarged to increase the surface area of the condensation process.

Table 22.1 System operation

Input			Output		
IR sensor	Level sensor 2	Level sensor 1	Pump 2	Condenser	Pump 1
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	0	1	0
1	0	0	1	0	0
1	0	1	1	1	0
1	1	0	1	1	1
1	1	1	1	0	0

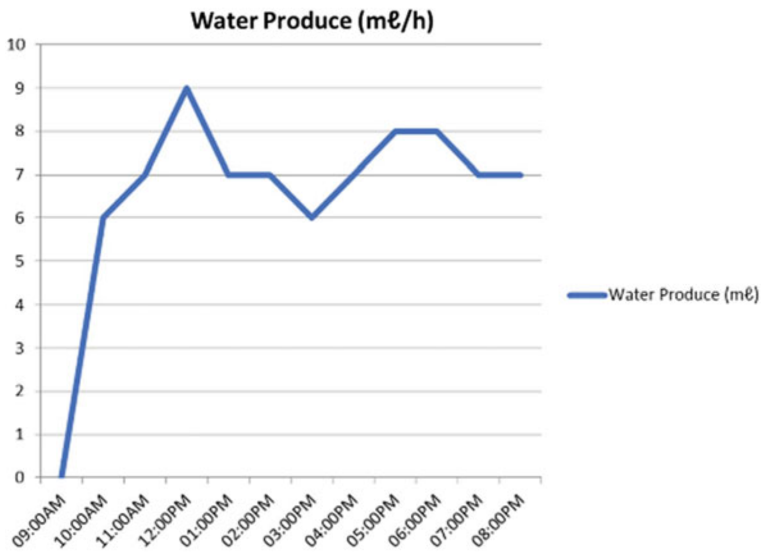

Fig. 22.8 Hourly water production results

22.4 Conclusion

The development of the atmospheric drinking water generator has been proposed. This project provides a system that can convert air into safe drinking water. This project can provide many benefits to communities who face problems to get clean drinking water, especially those in rural areas and also during disasters such as major floods. This project uses the principle of condensation of air, cooled to its dew point, and becomes so saturated with water vapor that it can no longer hold the liquid. Peltier or TEC is used as a condensation process medium to cool the air to the dew point. The condenser size of 4.5 cm × 4 cm × 2 cm can produce 6–9 ml of water per hour. In future, to increase the amount of water converted from the air, the size of the condenser used needs to be enlarged to increase the surface area of the condensation process.

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