Journal Publication of International Research for Engineering and Management (JOIREM)
Volume: 10 Issue: 01 | Jan-2025

IOT BASED COMBINED CYCLE OF DESALINATION AND RAINWATER COLLECTOR

Dr. Michael Raj F[1], Sujin M[2], Cruz Sanju J M[3], Dharun D[4], Berlin Joy P[5],
[1]Professor, [2]Assistant Professor, [3]UG Student
Department of Mechanical Engineering
Stella Mary's College of Engineering
Aruthenganvilai, Azhikal Post, Kanya Kumari District, 629202, Tamil Nadu
Corresponding Author: Dr. Michael Raj F michealraj@stellamaryscoe.edu.in & Sujin M sujin@stellamaryscoe.edu.in

---***---

Abstract -Nowadays the ground level water is reducing due to less rainfall and more lands become dry with no water. Many people suffer without water. This paper presents the electronic control unit based desalination process using solar energy. This process is 3-4 steps of pumping water from groundwater tank to the solar still or hood. The still is made up of stainless steel and the top side is covered with glass. The sunlight heated the water and become evaporated and that vapor condenses in the glass and the water droplet is collected in the pipe. The desalinated water enters into the fine filter and in the hose hold usages. The top side of the still or hood collecting rainwater to the sedimentation filter and the fine filter assembly. Both the rainwater and desalinated water for usages excess water is allowed to the underground storage tank. This system is more suitable for the coastal hamlets and household uses.

Key Words: Solar still, Desalination, Bluetooth technology, Energy efficient

1.INTRODUCTION

Water is the basic necessity of man along with food and air. The freshwater resources usually available are rivers, lakes and underground water reservoirs. However, the total volume of water on earth is 1.386 billion and about 71 % earth surface is water-covered, oceans hold 96.5 % of all earth's water, only 1.7 % in groundwater [1].Sun and earth have the same age of 4.5 billion years and the sun is at the center of our solar system [2]. The energy from the sun reaches the earth by radiation and it takes about 8 minutes and 20 seconds to reach the earth's surface and receives 1353 watts/m2 of solar energy. Earth is the only planet that has liquid water on its surface [3]. The construction of the still is simple and it consists of a tray, glass cover, charcoal absorber, boosting mirror and water collection segments. This type of system produces 3.22 to 3.515 liter of distilled water daily.

It's true that freshwater scarcity is associated with a large quantity of the solar resources. It seems also logical and attractive to associate those two parameters for countries where grid electricity is not spread widely and with easy access to seawater or brackish water. Solar desalination is not a new idea: it has been known for ages, antique sailors used to desalt water with simple and small-sized solar stills. It's also a fact that production of fresh water requires a large amount of energy: 1000 m3 of freshwater per day requires 10 000 tons of oil per year [1]. Though solar energy is often labelled as 'free energy', it's not so simple to evaluate feasibility and cost for solar desalination some technologies will not be taken into account in this paper: solar ponds, which are a direct desalination method, as well as desalination with electrodialysis (whose application is restricted to low salinity water).

An average male needs 3.7 liters of water per day and for an average female, it is 2.7 liter [4]. In 1950 India recorded 5400 m3 of water per person and it goes down by year and becomes 1900 m3 per person in 2000 and in 2011 availability of water per person is 1545 m3.It is known that from the 1951-2011 availability of water decreases [5] to around 70%.The main reason is overpopulation as well as pollution of drinking water and less conversion of non-portable water. Among 5% (7.6 crores people) of India's total population are deprived of safe water and country registers 1.4 lakh child death annually due to water [2].

There is 468 billion liters rainwater is wasted. This happens due to lack of awareness and irresponsibility of the people. Another fact that the people nowadays destroy the trees so the water cannot be observed and taken to the ground level. The freshwater is used for irrigation about 35% only and remaining water is discharged into the river and other sources of freshwater, but 90% of it doesn't meet the safety norms. In Kolkata 50% of freshwater that they have. In Bangalore which is a third most populous city in the country but they wasted water is unaccountable. In New Delhi, Chennai and in Mumbai waste water about 26 %, 20 %, 18 % respectively.

The important objectives of the novel desalination with rainwater system are to design the components like a hood, stand, water levels indicator and materials used. Then to fabricate the setup and assemble the components includes an electronic control module, etc. Finally, check the way of operation done by the individual components and to maintain appropriate performance. However, the entire system was monitored by the mobile applications using Bluetooth.

II. LITERATURE SURVEY

In India (from arid and semi-arid zones of western states of Rajasthan, Haryana, Punjab and Gujarat), 25%of groundwater is affected by salt, often rendering it unfit for human consumption and marginally fit foragriculture1,2. In such locations, options for managing soil and groundwater salinity include: R&D efforts to select and develop salt tolerant crops, soil amendment and planting of guard crops to reduce saline water logging. Desalination of groundwater using reverse osmosis (RO) membranes is another option, but expensive, requiring specialized membranes and electricity, which may be scarcely available in agricultural areas. In future, wider uptake of RO combined with photovoltaic (PV) panels is expected due to improved availability, performance and the ever growing need for desalination. A drawback with the RO desalination process is that it rejects a stream of concentrated saline water, disposal of which is problematic in inland situations. However, this waste stream can be usefully employed for cooling as reported.

Stream of water is drawn by suction, before combined flow passes into a diffuser section where higher pressure is restored . To demonstrate operation of jet pump at the concentrate outlet of an RO system, a pump was machined from brass stock. The diffuser section had an entrance (diam, 7.2 mm) diverging to a diameter of 22mm with an included angle of 10 degrees. As jet pump poses a resistance to the flow of liquid, it replaces throttle valve as typically used in a RO system. Jet pump was connected to the concentrate output of a RO rig incorporating a helical rotor pump; this rig installed at Aston University (UK)4. Jet pump was used to raise water from a tank to an outlet at a height of 1.55 m. This will be sufficient in practice to irrigate evaporation pads. To simulate variation in power input over a typical day in April in Northern India, power into helical rotor pump was varied (80-247 W), generating a pressure (7.25-14 bar) at inlet to jet pump. At each setting, flows were

measured using rotameters and by weighing of total output of jet pump.

Depicts the system architecture proposes three major microelectronics such as an IOT controller, actuator, and sensors. Where they are integrated together using a webpage interaction page to complete the entire process. Starting with the Rainfall sensor, where the sensor starts the process once it detects rainfall. Data transmission from the said sensor is effortless which helps the controller identify when to start or stop the entire process and analyze its current water conservation cycle. Next the pH sensor helps in finding the pH of the incoming rainfall. Once the pH is determined, the data is sent to the controller in this case, The Raspberry pi 4 to calculate its current Acidity. If the data received denotes that it lies between 1-5, It is considered as Acidic and if the range lies above 5 it is then concluded as Neutral. Based on the pH value, The controller gives instruction to redirect it to either the A or the B separate tanks of 5L each, where the process passes through a filtration test. The two tanks are primarily attached with two ultrasonic sensors each which records and transmits the liquid level in each of the tanks. Tank A contains the Acidic water that is to be treated and Tank B contains the normal or neutral water. Tank A is treated with Sodium Hydroxide and Soda Ash which are stored in a cartridge attached inside the tank with an easily replaceable side draw. It takes about 5 mins to treat the acidic water, even though it's a fast process. Finally, the treated and normal rainwater are collected in the main tank of 50 liters capacity which is also attached by an ultrasonic sensor. This tank acts as the final rendezvous, in which the output is attached to an automated water dispensary kit. This kit helps control the water level of the main tank and can be manipulated for each season throughout the years. All these devices are insulated in such a way that there is less to zero water damage. The entire process is set to be timed at approximately 30 minutes to complete for an average case, 15 minutes for the best case and 60 minutes based on the worst case. This is a sensor that measures the pH of the surrounding environment. It uses a common glass electrode to measure the hydrogen ion concentration in an electrolyte solution. In chemistry, pH is a measure of acidity or basicity. A pH level greater than 7 indicates an alkaline substance, while a pH level less than 7 signifies an acidic one. The pH scale ranges from 0 to 14 with 0 being perfectly acidic and 14 being perfectly basic. This sensor is connected to the raspberry pi board with 5V power supply, one GPIO pin and one ground water.

Ultrasonic sensors receive ultrasonic waves, which are high frequency sounds just above the range of human ability to hear. The ultrasound sensor detects these sounds and converts them into an electrical signal that is proportional to the level of sound in the received area. Some applications of this technology are for security purposes with regard to monitoring or measuring distances or sizes of objects, as well as for animal monitoring. In this model, it used to measure the water level in all the tanks used. It uses a Trig and Echo pin connection to transmit data, so they are connected to two GPIO pins and requires a 5V power supply pin Automatic water dispensers are the forefront of the model, it includes the main feature of pumping the water collected from the main tank in required or requested amount by the system or the user. It is connected to a 110V power supply and also to the GPIO board of the Raspberry Pi 4.Real Time Control technology in Rain Water Harvesting system to improve performance for water supply, environmental flow protection and flood protection. It uses four techniques that include Flood protection, which is used to minimize the tank overflows through 24 hour uniform release of any overflows, Supply maximization is a process that involves increasing the amount of tank water that's available for supply and preserving the flow of water. It's done to minimize the effects of storm release and maximize efficiency. Dalin et al., [12] establish a study on food trade route and their impacts on ground water depletion and water holding potential of various regions. Helmreich et al., [13] has elaborated the various techniques in rainwater harvesting and explains about the desalination method. Bhargava et al., [14] describes about acid rain and its ecological consequences that were widely accepted in many countries. Propose a framework that introduces an idea to modernize water harvesting using a well-known setup that incorporates a wide area in which a water sensor is controlled with the help of an Arduino that operates as a guide to the system. A servo engine is integrated with the water sensor which is fueled through the Arduino. The water sensor decides the operation of the signals that are sent to the Arduino, servo engine is launched by the Arduino and the end goal is to make water accumulation open, this also triggers an electronic mail to indicate its status to the user. Martin Ober Ascher et al., [10] Smart rain barrels are made to be used for temporary storage and control of storm water. They can also be used for harvesting rainwater. The concept of a smart rain barrel combines LID and ICT in a single system.

The smart RWH scheme proposed here are capable of controlling the water level in the tank to ensure that the spare storage capacity is always maintained. This study explores the various advantages of using smart RWH schemes for improving the efficiency of integrated Urban Water Systems (UWS).Its tank can abate local floods during rainfall scenarios and can supply the harvested rainwater to non-potable residentials for consumption. The performance of the UWS can be assessed using the WaterMet2 model with smart RWH schemes.

Introduce a method that uses a smart water meter that will be monitored by the user and will help them reduce their water usage. It can also alert them when they over-use water. This system is based on the IEEE 802.15.4 wireless sensor network (WSN) and is used to monitor and control water quality. ContikiOS LibCoAP is an open-source application that was used to create the system through visualization and monitoring achieved using web-based systems .A pair of 2 Liter small tanks and a 5 Liter tanks were used to conduct the experiment with the above apparatus. A customized water filter was used to separate impurities and dust particles at the preliminary stages. For Acidic water, a solution of water mixed and with lemon juice were used. The precise results were yielded from the experiment and took over 10 mins for the conversion of acid water to normal water using Sodium hydroxide and Soda Ash. The servo motor performed well using a lightweight sheet of plastic cover to separate the collected water.

III. MATERIALS AND METHODOLOGY

3.1 OBJECTIVE

The important objectives of the novel desalination with rainwater system is given below.

- To design the components like hood, stand, water levels indicator and materials used.
- To fabricate the setup and assemble the components includes electronic control module, etc.
- To check the way of operation done by the individual components and to maintain appropriate performance.
- To control the entire system by monitoring mobile applications using Bluetooth
-

3.2 PROPOSED SYSTEM

The working principle of the IOT Based Combined cycle of desalination and rain water collector The solar still is an apparatus that uses solar radiation to distill salt or brackish water to produce drinkable water. The solar still is used to absorb the sun's short-wave energy and start sheeting the water. As the temperature of the water rises, the liquid H20 is converted into steam and evaporated towards the glass ceiling, this purifies H_2O in the trough. After the water begins to evaporate, it hits the glass ceiling. The water slowly condenses on the glass, causing pure water droplets. Since the glass is angled down towards the second trough, the water droplet rolls down into the clean water trough. During rainy seasons the solar power is very least. At that time the rain water is collected by the external side of the hood. After that the rain water send to various filters then used for house hold applications. Rain water Purification The clean water from the solar still is subjected to the addition of minerals to improve taste and wealth. But the rain water system collect the rain water and is supplied by means gravitational feed by physical processes such as filtration, sedimentation and distillation, Also biological process include sand filters, carbon filters and ultraviolet light radiation. Figure 1. Schematic diagram of the model house and different Components of an advanced distillation system.

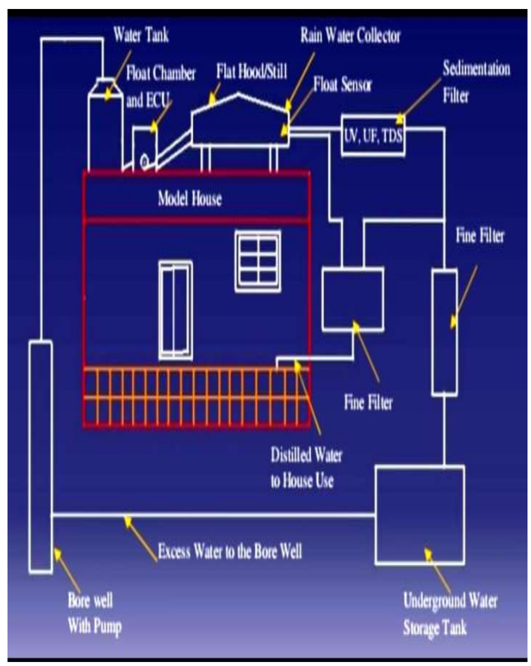


Figure 1. Schematic diagram of the model house

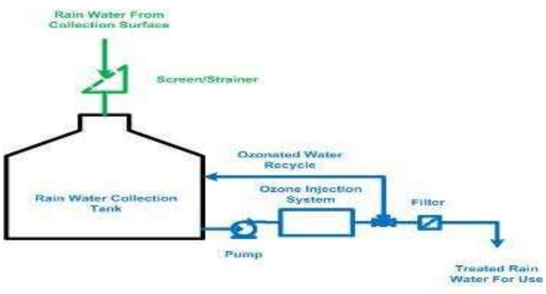
4 COMPONENTS EXPLANATION

4.1 SOLAR STILL

The solar still is an apparatus that uses solar radiation to distill salt or brackish water to produce drinkable water. The solar still is used to absorb the sun's short-wave energy and start heating the water. As the temperature of the water rises, the liquid H20 is converted into steam and evaporates towards the glass ceiling, this purifies H20 in the trough.

After the water begins to evaporate, it hits the glass ceiling. The water slowly condenses on the glass, causing pure water droplets. Since the glass is angled down towards the second trough, the water droplet rolls down into the clean water trough. During rainy seasons the solar power is very least. At that time the rain water is collected by the external side of the hood. After that the rain water send to various filters then used for house hold applications. Rain water Purification The clean water from the solar still is subjected to the addition of min.

4.2 RAIN WATER PURIFICATION



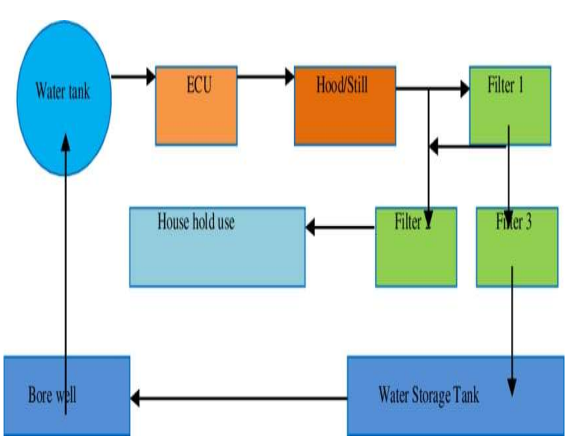
Ozone Rainwater Treatment System

4.3 ELECTRONICS CONTROL UNIT (ECU)

Now a day's technology is running as time and has completely occupied the life style of human beings. Even though there is importance for technology in routine life. The mobile phones with simple graphical user interfaces are available at a reasonable cost and also each and every person even farmers have access to it. The term IoT refers to an open specification for a technology to enable short-range wireless voice and data communications anywhere in the world. Mobile Operated IoT based desalination system is user friendly, reliable and automated water pumping system for desalination process. IOT technology present in mobiles is to operate the microcontroller with IoT device attached to it. The automation technology implemented the electronic unit is monitoring the water pressure from the supply tank to the still, amount of filtration, inside temperature, heat capacity, maintain the still water level, etc.

The electronic unit is monitoring the water pressure from the supply tank to the still, amount of filtration, inside temperature, heat capacity, maintain the still water level, etc.

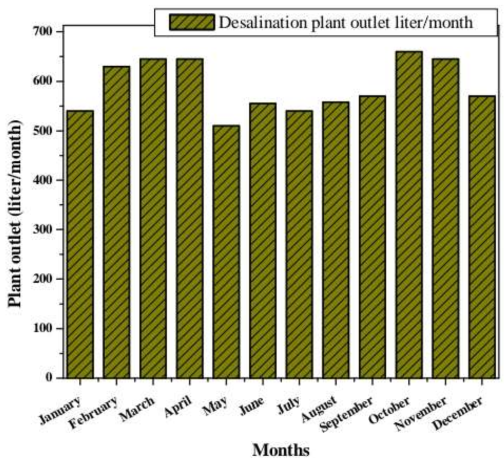
Line diagram of an advanced distillation system



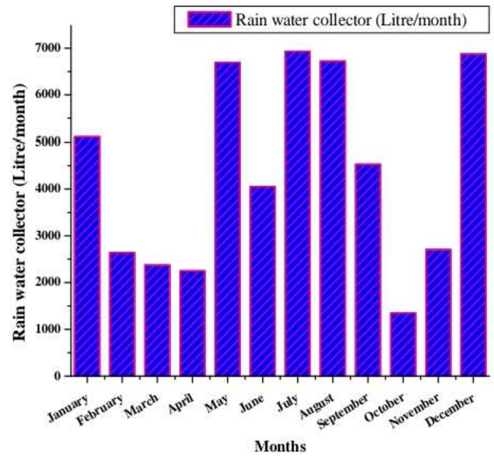
An electronic control unit (ECU), also known as an electronic control module (ECM), is an embedded system in automotive electronics that controls one or more of the electrical systems or subsystems in a car or other motor vehicle. The electronic engine control unit (ECU) is the central controller and heart of the engine management system. It controls the fuel supply, air management, fuel injection and ignition. Short for Electronic Control Unit, the ECU is a name given to a device that controls one or more electrical systems in a vehicle. It operates much like the BIOS does in a computer. The ECU provides instructions for various electrical systems, instructing them on what to do and how to operate. An electronic control unit (ECU) is a small device inside a vehicle that controls one or several electrical systems in that vehicle. It tells electrical systems what to do and how to operate. ECU's core is a microcontroller and it is controlled by embedded software. An ECU is essentially a small computer that manages the actuators on your car's engine to ensure it performs flawlessly. The ECU controls everything in the engine, including the wheel speed, braking power, ignition timing, idle speed and the air/fuel mixture. An engine control unit (ECU), also called an engine control module (ECM), is a device which controls multiple systems of an internal combustion engine in a single unit. Systems commonly controlled by an ECU include the fuel injection and ignition systems. One of the most obvious benefits of ECU tuning and remapping is that you can increase the power and torque output of your engine. By optimizing the ECU settings, you can unleash the full potential of your engine and make it more responsive and agile. The European Currency Unit (ECU) was the monetary unit used by the European Monetary System (EMS) before being replaced by the euro. It is widely used in the engine control units of cars and motorcycles aiming to improve the engine performance, fuel efficiency, cleaner emission of exhaust gas, and drivability. DC power supplies for ECU circuit drive and control are all available in a Matsusada Precision.

4.4 IOT TECHNOLOGY

Now a day's technology is running as time and has completely occupied the life style of human beings. Even though there is importance for technology in routine life. The mobile phones with simple graphical user interfaces are available at a reasonable cost and also each and every person even farmers have access to it. The term IoT refers to an open specification for a technology to enable short-range wireless voice and data communications anywhere in the world. Mobile Operated IoT based desalination system is user friendly, reliable and automated water pumping system for desalination process. IOT technology present in mobiles is to operate the microcontroller with IoT device attached to it. The automation technology implemented the system for easy monitoring and control.This means everyday devices like toothbrushes, vacuums, cars, and machines can use sensors to collect data and respond intelligently to users. The Internet of Things integrates everyday "things" with the internet. Computer Engineers have been adding sensors and processors to everyday objects.The Internet of Things (IoT) describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. IoT network is the network with physical



Now a day's technology is running as time and has completely occupied the life style of human beings. Even though there is importance for technology in routine life. The mobile phones with simple graphical user interfaces are available at a reasonable cost and also each and every person even farmers have access to it. The term IoT refers to an open specification for a technology to enable short-range wireless voice and data communications anywhere in the world. Mobile Operated IoT based desalination system is user friendly, reliable and automated water pumping system for desalination process. IOT technology present in mobiles is to operate the microcontroller with IoT device attached to it. The automation technology implemented the system for easy monitoring and control. This means everyday devices like toothbrushes, vacuums, cars, and machines can use sensors to collect data and respond intelligently to users. The Internet of Things integrates everyday "things" with the internet. Computer Engineers have been adding sensors and processors to everyday objects. The Internet of Things (IoT) describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. IoT network is the network with physical interconnected objects embedded with sensors, smart devices that connect and exchange data with other devices and systems without human intervention. Generally, IoT is most abundant . **The collection of rainwater for the month of January to December.**



manufacturing, transportation and utility organizations that use sensors and other IoT devices; however, it also has use cases for organizations within the agriculture, infrastructure and home automation industries, leading some organizations toward digital transformation. In summary, the Importance of IoT, Internet of Things is transforming businesses and driving the next industrial revolution. By instrumenting the physical world with smart sensors and actuators, IoT enables organizations to monitor, optimize and automate processes across every industrious devices are pieces of hardware, such as sensors, actuators, gadgets, appliances, or machines, that are programmed for certain applications and can transmit data over the internet or other networks. From smart homes and smart watches to cloud computing for industrial applications, the benefits of IoT are reshaping business. This technology has witnessed exponential growth thanks to its ability to provide seamless connectivity between internet-connected devices and systems. IoT applications run on IoT devices and can be created to be specific to almost every industry and vertical, including healthcare, industrial automation, smart homes and buildings, automotive, and wearable technology. Increasingly, IoT applications are using AI and machine learning to add intelligence to devices. In a nutshell, IoT works like this: Devices have hardware, like sensors, that collect data. The data collected by the sensors is then shared via the cloud and integrated with software. The software then analyzes and transmits the data to users via an app or website.

- Smart appliances (stoves, refrigerators, washers and dryers, coffee machines, slow cookers)
- Smart security systems, smart locks, and smart doorbells.
- Smart home hubs (that control lighting, home heating and cooling, etc.)

IoT and Artificial Intelligence will reach more industries and business settings as they can help automate processes, reduce downtime, reduce operating costs, and increase efficiency. Some examples of AI and IoT include self-driving cars, robots in manufacturing, and smart thermostat solution.The internet of things is a technology that allows us to add a device to an inert object (for example: vehicles, plant electronic systems, roofs, lighting, etc.) that can measure environmental parameters, generate associated data and transmit them through a communications network. IoT plays a crucial role in enhancing employee productivity by streamlining workflows, automating tasks, and providing real-time access to information.

Table 1. Collection of desalination and rainwater plant

Month	Need water per head (liter/ month)	Plant water (litre/ month)	Amount of rain (mm)	Rainwater Collection month/ Litre	Using Ground Water (Litre)	% of water saving
January	450	540	65.4	5100	-	51.2
February	480	630	33.9	2640	-	1.1
March	510	645	30.4	2370	285	-12
April	525	645	29	2250	420	-18.7
May	540	510	85.9	6690	-	61.9
June	492	555	52.1	4050	-	37.1
July	516	540	89.0	6930	-	63.1
August	540	558	86.4	6720	-	61.3
September	570	570	58.3	4530	-	41.7
October	585	660	17.6	1350	1395	-103.3
November	465	645	34.8	2700	-	3.3
December	489	570	88.3	6870	-	62.8

V. CONCLUSION

The global potable water demand is increasing rapidly with increasing population and industrialization. Solar stills have a good chance of success in India for lower capacities which are more than 20 km, away from the source of fresh water. The design, construction, and operation of solar still are very simple. Also operational and maintenance cost is very low. Since the initial investment and water production cost is low, it could be one of the acceptable options for providing drinking water for a single house or a small community area, remote and coastal regions. Therefore it concludes designed and fabricated of the solar still can be used for conversion of impulse water to potable water and properties of condensed water is tasted and safe for drinking.

The servo motor performed well using a lightweight sheet of plastic cover to separate the collected water. All the above processes were monitored, recorded and manipulated using the webpage that was proposed. Experiments with pad-and-fan GH at GB Pant University support feasibility of re-using saline water rejected from RO system for evaporative cooling. Based on rates of water consumption, no difference was noted in system behaviour when using saline water, compared to when operating with pure water. The Amount of water saved through re-use was 122 l d-1 in October, corresponding to the amount of water consumed in evaporative cooling pads, which conventionally require a freshwater source. This saving is equivalent to 6 l d-1 m-2 of GH floor area and can be expected .

As well as conserving groundwater and making more water available for other purpose in arid areas, such re-use can contribute to management of waste concentrate rejected by RO, since evaporative cooling process reduces volume of this concentrate. Under full sunlight, PV-fan consumed 175 W, compared to 1500 W (2 HP) for the pair of mains powered fans, thus achieving an 8-fold energy saving.
Another improvement comes from the application of jet pump to enable larger evaporative pads and GH areas to be cooled by the same amount of RO reject water; jet pump boosted the flow of cooling water by a factor of 2.5 to 4. Jet pump is an alternative means of recovering energy from reject stream compared to standard devices such as turbines normally used on larger RO systems. These energy efficiency measures favour the use of PV, which can provide secure power and thus facilitate cultivation of high-value crops in cooled GH environment without risk of mortality from power outages that are likely to occur with mains operation.

REFERENCES

1 G.M. Zaki improved performance of solar stills, solar energy and the arab world (1983).
2 G.Mink Air blown solar still with heats recycling (1988).
3 A-J N Khalifa- an experimental study on modified simple solar stills (1988).
4 A. Shurti thermal modeling of a double condensing chamber solar still, an experimental validation (1999).
5 E. Rubio Cavity geometry influence on mass flow rate for single and double slope stills (2000).
6 A.S. Nafey solar still productivity enhancement, energy conversion and management (2002).
7 R. Thripathi study of heat and mass transfer inindoor condition for distillation (2003).
8 H.S Aybar, Mathematical Modeling of an Inclined Solar Water Distillation (2006).
9 R. Tripathi and G,N. Tiwari, effect of Water Depth on Initimal Heat and Mass Transfer for active solar distrallization , desalination (2004).