Desalination and Water Monitoring System

Siddhant Purohit[1], Raman Chamle[2], Akshay Pohandulkar[3]

[1]Siddhant Purohit, Dept of E & TC Engineering, Zeal College of Engineering, Pune, Maharashtra.
[2]Raman Chamle, Dept of E & TC Engineering, Zeal College of Engineering, Pune, Maharashtra.
[3]Akshay Pohandulkar, Dept of E & TC Engineering, Zeal College of Engineering, Pune, Maharashtra.

---***---

Abstract - *Water covers over 70% area of the earth out of which 97.5% is salt water and 1.5% of water is frozen so that means only 1% of water can be used [1]. And as we are aware of current scenario of the world, many people are struggling as we are left with limited amount of fresh water, this problem is getting worse day by day [2]. So the need arises for converting sea water into useable water source. This could solve major issue of water shortage. The process of removing salt from water and softening the water is known as desalination. There are various methods for desalination, but they aren't available in small compact structure which can be fit in homes near coastal areas or in boats etc. We are going to build a small box which could easily fit in small space and we could use water instantly from it right after the process. This small box will contain a monitoring system for the testing the water, sea water contains hardness in range of 6630ppm and the water which could be used for drinking should have the hardness of 15-375 ppm so monitoring is necessary. Also, the whole process will be automated and we will get the result of condition of water in real time.*

Key Words*: *Arduino, Boiler, Cooler, Desalination, Water Monitoring system.

1. INTRODUCTION

Fresh water source is continuously decreasing, major city of India, Chennai in year 2019 ran out of their yearly supply on 19th June 2019. And many such problems are faced by citizens of India alone, Lack of fresh water is a Global concern. Desalination is used by major countries of world. Various processes for desalination are available such as "Reverse Osmosis" In reverse osmosis the salt water is made to pass through a semipermeable membrane under pressure (1200 psi) this allows pure water to flow through membrane it uses the phenomenon of Osmotic pressure difference between sea water and pure water [4]. Disadvantage of reverse osmosis is it requires high amount of energy to create pressure on sea water using pump also some types of membrane are sensitive toward chlorine thus additional chemicals might be required. Another method is "Nano filtration" this method is similar to reverse osmosis but pressure requirement is less (70 to 140psi) but this method alone is not useful for successfully remove salt water and soften the water. "Electro dialysis and electro dialysis reversal" this is also a method of desalination, this method requires user to electro dialysis to separately dissolve minerals in both side of membrane, In this method the

treatment cost is directly related to TDS concentration in feed water, it best for water with TDS concentration till 4000mg/l. Another method is "Evaporating and condensation" here water is first evaporated leaving all the precipitate behind and then finally cooling the vapor we can get fresh water which can be consumed, lot of energy is consumed for evaporating water but if we have enough time, we can use solar energy for evaporating. In this article our main focus will be on last method that is "Evaporating and condensation". Projects on all the method mentioned above are currently in market but so such module is present which could easily fit in house and the quality of water could be monitored in real time. Here we have made such device [3].

2. METHADOLOGY

The block diagram of this module is as follows. As we can see first the sea water is collected and initial test are performed on this water, usually the water contains high amount of turbidity and the water is alkaline that is its pH value is normally 8.1. Then with the help of motor (12v DC motor) the water is pumped into boiler. The metal coil is heated up and water begins to evaporate, this steam is then passed through the coil which condenses the vapor into water. After the cooling process most of the impurities are separated from the water but as this water could be used for drinking purpose extra measures are taken to make it safe for use. Thus, to reduce the hardness, the water it is passed through the resin bed. Hardness of water is measured in ppm that is part per million, these parts are mostly contamination and chemicals mixed with the water [9]. After the water is passed through the resin bed it is then pushed into filtration system. In the filtration usually 3 operations are performed, they are Sedimentation, Filtration and Disinfection [8]. In Sedimentation water is kept still so that heavy contamination shrinks at the bottom but this method is not required here as in first place heavy contamination is not evaporated, second method is Filtration here water is passed through filters or soil bed to remove micro contamination, resin bed performs the similar action and third process is disinfection her chemical like chlorine, sodium hypochlorite, calcium hypochlorite are added to increase purity of water but this should be added in limited quantity as excess can trigger unnecessary chemical reaction in water which may be harmful for human beings. Here we are going to add household bleach (NaClO) in ratio such that 1 gallon of bleach is added in 1000 gallon of water. After all this process the fresh water is again tested for purity, it is judged on basis

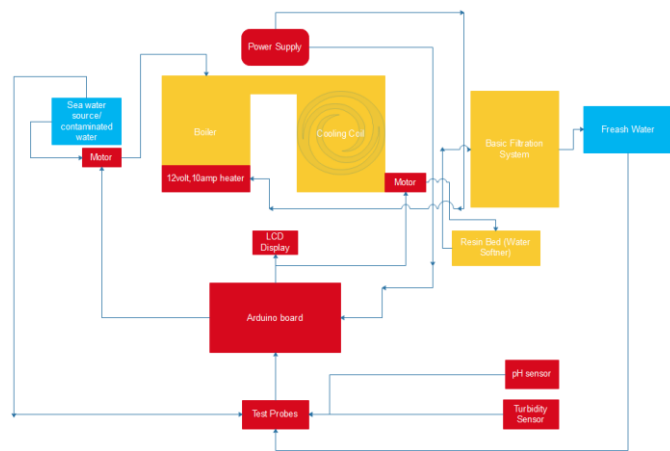of turbidity and pH. If turbidity is less than 4 NTU and pH is equal to 7 then the water is safe for drinking.

Fig - 2.1: Block diagram of sea water convertor and filtration system
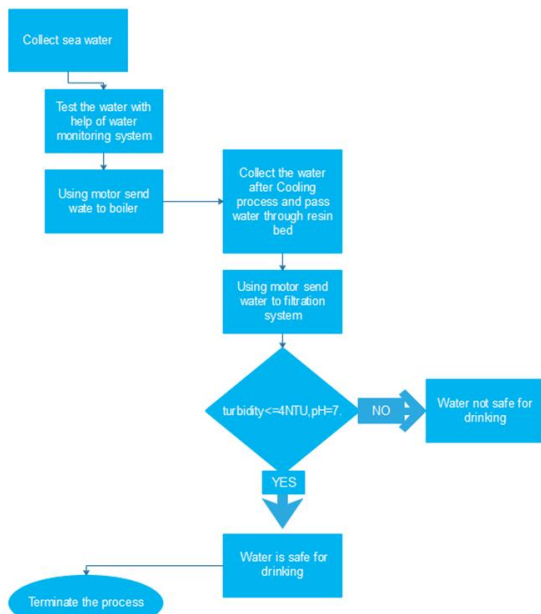
3. FLOWCHART OF WORKING

Fig - 3.1: Flowchart of working

In above diagram NTU means Nephelometric Turbidity Unit and World health organization has declared that the turbidity of the drinking water should not be more than 5 NTU ideally it should only be 1 NTU but water is safe until 5 NTU and does not exhibit any harmful effect on human body.

4. SENSORS

Turbidity sensor: - Turbidity sensor works by sending a beam of light in water to be tested and a light detector is placed at 90 degree of the source. The light beam gets dispersed by the suspended particles that is turbidity in the

water and the detector detect the reflected light and based on that turbidity is measured in NTU [6].

> NTU=a*TSS*b
> Where a= Regression-estimated coefficient.
> b=It is approximately 1.
> TSS= Suspended solid measurement it is measured in mg/l.

pH sensor: - This sensor has glass electrode filled with neutral solution and the contain of hydrogen ion is known. When this electrode is dipped in solution to be tested then the sensor compares the hydrogen ion of solution to be tested and hydrogen ion of solution in the glass electrode. If the solution contains more hydrogen ion than solution in glass electrode then the solution is acidic or if hydrogen ions are same then solution is neutral and in last case if the hydrogen ions are less than solution in glass electrode then the solution is alkaline.

> pH of water should be 7, that's ideal pH value for neutral solutions. pH value in range of 1 to 6 indicated that the solution is acidic, 7 is neutral and values more than 7 is alkaline.

Analog to digital convertor: - As we know both the sensors used for testing the quality of water that is turbidity sensor and pH sensor are analog sensor. Analog values are difficult to store as well the processing of digital signals are quite easy as compared to analog signals for all these reasons there is need of converting analog values into digital values for this reason analog to digital convertor is used. This feature is inbuilt in Arduino board.

Table - 4.1: Sensors details

Sr. No	Name of sensor	Response Time	Type of sensor	Power requirement	Operational temperature
1	Turbidity sensor.	Less than 500 micro seconds.	Analog sensor.	Voltage: 5VDC, Current: 30mA (max).	-30 to 80 degree Celsius.
2	pH sensor.	Less than 500 seconds.	Analog sensor.	Voltage: 5V (AC, DC).	0 to 80 degree Celsius.

5. OTHER HARDWARE USED

12 volt DC motor: - This motor works on principle of Fleming's right hand rule it states that whenever current carrying conductor comes in contact with magnetic field, it experiences mechanical force and formula for the magnitude can be found out by equation F=BIL, here F is magnitude of force, B is magnetic flux density, I is current and L is length of conductor. Its current requirement is 0.2 ampere at no load and up to 1.2 ampere at full load. It can go up to speed of 5000 RPM (revolutions per minutes).

12-volt 10 ampere electric water heater: - This module is directly available in market it works on principle oh heating the coil using electric power supply.

Cooling Coil: - This is simple hollow copper wire bend in the shape of coil, as this is placed in water its temperature is less this helps steam to condense easily also the hollow space and spiral shape enhances the cooling process.

6. OBSERVATIONS AND CALCULATIONS

- In initial test of water from Arabian Sea showed that its turbidity was 15 NTU (this could change from place to place; turbidity of Sea water depends on various factors like for example place with corals may have high turbidity) and the pH value was 8.2.
- For pumping action, we use 12volt DC motor this motor pumps 3litres of water per minute. We use 500ml water at a time for conversion and motors fills that amount of water in 10.3 seconds.
- For heating the water, the metallic container of capacity 600ml is used, Heater is 12-volt 10-amp water heater, which is placed in the container. The initial temperature of water is 27 degree Celsius (at the time of experiment) and the water is raised to its boiling point that is 100 degree in 3minutes 46seconds, after this point water starts to evaporate. This process can be made faster if we could keep water in vacuumed container.
- After the water is completely it is passed through a coil which is kept in water, this tube is made using copper and can convert steam of 500ml water into water in 8minutes 20seconds and we can accelerate this process by adding Ice into the water which is around the coil.
- Later process doesn't need much time. Filtration through resin bed is fast and then only thing that remains is adding bleach to the water. At last the quality of water is displayed, the response time of both sensors is less than 5 seconds.
- Thus, total time for complete process is 17 minutes 25 seconds. This time may change according to surrounding conditions for example if temperature of surrounding is more than evaporation process is quicker and if the surrounding temperature is less than cooling process is less.
- Following things should be done for maintenance of the module, cleaning the container used for heating after each cycle of desalination, cleaning the pipe of first motor after 10 cycles of desalination, regenerating resin bed after 100 litres is passed through it. Regeneration depends upon many factors but in this module, it is preferred to regenerate bed after 100 liters.

7. CONCLUSION

In this paper we have worked on the module which will help us to use saline water in day to day life, thus the problem of limited fresh water supply could be solved to certain extent. Also, this module can be set up in our house like normal filtration system and take water source directly from sea, this module will keep desalinating water and will also filter and store the water. User could monitor the quality of water in real time and can be assured before using it for drinking purpose.

8. FUTURE SCOPE

- This project can be extended on large scale so that it could be used by a village or small community of people, in this big project solar energy could be directly used to heat up the water. Also, solar energy can be converted into electric energy and this energy could be used for other operations in this module for example for driving motors or power supply to controllers.
- Automation can be added to this project so that user supervision is not required for maintenance of this module.
- Various other chemicals (medicines) can be added to the water in filtration system for fighting against certain viral diseases like for flu or infection (when used for public water source).
- Automated filtration system could be used in this module.

9. ACKNOWLEDEGEMENT

We would like to thank our college staff for helping us out with this project and providing us guidance wherever required. Also, we would like to that our Project Guide, Assistant Professor, Mrs. Shenhal Ghodke.

10. REFERENCES

[1] https://rainforests.mongabay.com/09water.htm

[2] https://www.sciencedirect.com/science/article/pii/S1364032109002767

[3] Tamin Younos and Kimberly T. Tulou, "Overview of Desalination Techniques", Universities Council on water resources Journal of contemporary water research and issue 132, Pages 3-10 December 2005.

[4] Mohammad H. Albeirutty, Omar A. Bamaga, Alberto Figoli and Enrico Drioli, "Desalination Research and Development in Saudi Arabia: Experience of the Center of Excellence in Desalination Technology at King Abdulaziz University", Journal of Membrane Science & Research.

[5] https://www.mdpi.com/2071-1050/11/15/4227

[6] Licai Zhang, Yaoguang Wei, Yingyi Chen, Daoliang Li and Lihua Zeng, "Research of Intelligent Turbidity Sensor", 2014 by IFSA Publishing, S. L.

[7] https://www.teachmemicro.com/arduino-turbidity-sensor/

[8] Rebeen Nasruldeen Qadar, "Investigations into the effectiveness of large size membrane elements for RO desalination RO: water treatment by reverse osmosis", 2013

[9] Sharon O. Skipton and Bruce I. Dvorak, "Drinking Water Treatment:Water Softening (Ion Exchange)".