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Enhancement of Water Purification Process Using Smart IoT Monitoring System

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***Abstract*—The existence of human life predominantly depends on the availability of pure water. Due to the increase in pollution, various toxic containments would have been dissolved in water which causes harm to the body. Therefore, it is necessary to have proper filtration to remove these toxic containments from water. One of the most cost-effective ways of water filtering is Reverse Osmosis (RO). Total dissolved solids (TDS) are the most common contaminant in water. Many RO purifiers nowadays deliver water with TDS levels ranging from 30 mg/lt to 50 mg/lt. Low TDS value in water deprives the human body of important nutrients and leads to health problems. The proposed system is integrated with a feedback TDS meter to measure the total dissolved solids and peristaltic pumps are used to manually inject the TDS if the output of the TDS value is low, a pH meter is used to measure the pH value of the water, flow meter to manually or automatically set the water flow, it also can debug the errors automatically and also the system has the Bluetooth connection as well as server connection which has been integrated with the android application to monitor the purifier through remotely. This system is user-friendly it can be detached from the purifier when it is not in use and can be attached to the new purifier commonly known as Retrofitting. If there is any damage in the purifier, the system will identify the damage and will automatically identify the damage and raise the ticket to the support with a detailed description.**

***Index Terms*—Purifier, peristaltic pumps, pH, Reverse Osmosis, Retro Fitting, TDS.**

I. Introduction

Water covers almost 70% of the earth's surface, among which only 2.4% is of freshwater which is feasible for drinking. Water is one of the major resource in our day to day life and almost 70% of the water is used in the food production in most of the regions across the globe. The brain is the most important organ in the human body, and it is made up of up to 80% water. Inadequate water consumption causes extreme dehydration of the brain, resulting in mental disorientation and retardation. People can survive for a few days without food, but only for 2-3 days without water. Water is essential for the existence of all living things on the earth, including plants, animals, and all other forms of life [1].

Any procedure that enhances the quality of water to make it suitable for a certain end use is referred to as water treatment. The final use might be for drinking, irrigation, maintaining river flow, water enjoyment, or a variety of other things, including being securely disposed of back into the environment. Water treatment includes eliminating contaminants and undesired components or lowering their concentration to make the water appropriate for the intended end use. This process, which also provides benefits for drinking and irrigation use, is essential for maintaining human health [2].

We should first understand the principles of osmosis before delving into the specifics of reverse osmosis. Osmosis is the process by which water moves from a less concentrated solution into a more concentrated one across a semi-permeable membrane, as you may recall from high school chemistry. In other words, the filter equalises the concentrations of the polluted and clean water, which is not what we want for our drinking water. Osmotic pressure is generated by this movement [3].

Reverse Osmosis (RO) is the process used to create water that is free of suspended particles. This purification technique employs a semi-permeable membrane that eliminates suspended particles by applying a pressure larger than the osmotic pressure to the higher concentration side in order to increase the amount of water with low concentration. Demineralization is the process of eliminating all minerals (ions) from both natural and RO-treated water [4].

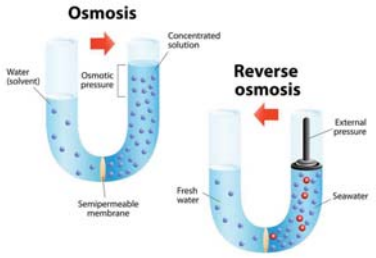

Fig. 1. Reverse Osmosis Process

The main issue with RO water purifiers is that around 70% to 80% of the water is lost during the purification process, as well as the removal of minerals from the water (demineralization). If the input water has a TDS value of less than 500 mg/litre, no demineralization treatment is required. Any source of water's pH value is a measure of its acidity or alkalinity. The measurement of pH level mainly depends on

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the amount of hydrogen atoms present in the water. If the pH value is in between 0-6 then water is said to be acidic, if it ranges from 8-14 then it is said to be basic and 7 being the neutral value which means neither acidic nor basic.

II. HARDWARE

A. Block diagram

The designed integrated system is connected to multiple devices to monitor the Raw water and purified water levels in the tank and to control various parameters in the process of water purification as shown in the fig 2.

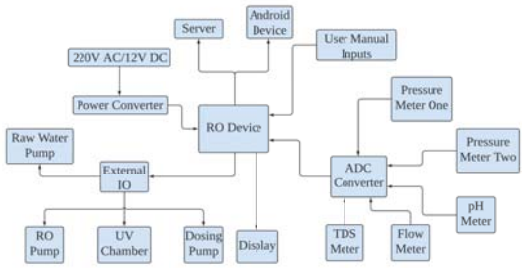

Fig. 2. General block diagram of integrated device

B. Total Dissolved Solids (TDS) Meter

TDS stands for total dissolved solids in a solution. The concentration of these dissolved substances is determined using a TDS metre. These components include metals, solids, minerals, calcium, and other inorganic and organic chemicals that improve a solution's electrical conductivity (EC). Consequently, EC may be used to calculate TDS. TDS is measured in terms of milligrams per litre (mg/L). In the process of RO filtration water is said to be pure of the TDS value is low and comparatively impure if the TDS value is high. Reverse Osmosis (RO) is an example for water purification, where for TDS value ranges from 0 to 10 for pure water and 20 to 100 for impure water [5].

Fig. 3. TDS Sensor

C. pH Meter

pH meters determine the pH of a solution by evaluating the electrical potential difference between the two electrodes. A type of electrochemical pH sensor known as a combination pH sensor has both a measuring electrode and a reference electrode. While the reference provides a constant signal for correlation, the measuring electrode detects variations in pH value. The millivolt signal in pH units is demonstrated using a high impedance instrument.The sensor then shifts from displaying the potential to indicating the pH level. In contrast to other pH testing instruments, pH metres need greater calibration and maintenance. The metre electrodes must be kept clean, serviced, or changed in accordance with the manufacturer's instructions [6].

Fig. 4. pH Meter

D. Water Flow Sensor

To monitor the rate of flow of water and determine how much water went through the pipe, water flow sensors are put at the water source or pipelines. Litres per hour or cubic metres are used to measure water flow rates. A plastic valve through which water can travel makes up a water flow sensor [7]. The presence of a water rotor and a hall effect sensor allows for the detection and measurement of water flow. The rotor is turned when water passes through the valve. By doing this, the change in the motor's speed may be seen. The hall effect sensor calculates this change and outputs it as a pulse signal. So, it is possible to gauge the water's flow rate [8].

The water flow sensor may be utilised with hot, cold, or warm water as well as with clean and unclean water. These sensors are offered in a variety of sizes and flow rate ranges. With micro-controllers like Arduino, these sensors may be readily interfaced. For this, a 162 LCD display, a Hall effect water flow sensor, an Arduino micro-controller board for processing, and Breadboard connection wires are needed. The sensor is positioned at the pipe opening or the water source inlet. Three wires are connected on the sensor. Red wire for supply voltage connection. a yellow wire to gather output from

Fig. 5. Water Flow Sensor

the Hall effect sensor and a black wire to connect to ground. 5V to 18V of DC supply voltage is needed [9].

E. Peristaltic Pump

Peristaltic pump which is also referred as hose or tube pump works on the principle of positive displacement. Rollers that rotate and squeeze a flexible tube against the pump housing to force fluid through the tubing. The tube expands as the roller passes over it, creating a vacuum that lets more fluid in. At least one roller shuts the tube while it is in use. As a result, there is no longer a need for valves. Either a motor turns the rollers directly, or a gearbox does. The most common uses for tube pumps include industrial peristaltic pumps and medical peristaltic pumps [10].

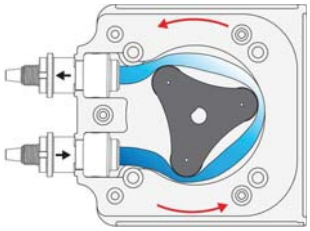

Fig. 6. Peristaltic Pump

III. Methodology

Due to over increase in pollution the water is getting contaminated in lakes, reservoirs, ponds, and rivers. The polluted water cannot be used directly used for drinking before to that the water should be treated by to get the pure water by the process for reverse osmosis. The main drawback of reverse osmosis process is it makes the water with zero TDS value. The designed integrated system will continuously monitor the complete purification process form the overhead tank till we get the pure water.

The designed system as shown in fig 7. is connected to the various valves that are present in the purification system. First, it checks for the water level in the collection tank, if the water not above the threshold limit it will automatically turns on the motor for the filling up of tank. Once the tank is filled then it check for the water level in the treated water tank, if the treated water tank is full then system pauses the purification process, if water level in treated water tank is low then the system starts the purification process.

To start the purification process the system turns on the pressure pump to push the raw water from the collection tank to the Multi Grade Filter to remove the suspended particles, dirt and dust present in the water. The water is made to flow through media bed through inlet valve. The media bed is made up of multi layers like sand, pebbles and gravels which will be arranged according to the size. Filtration takes place in each layer of the media when the raw water moves through them. The water's suspended solids, grit, and debris are all collected by the media bed, and only clear filtered water exits the filter's outlet. The filtered water from the Multi Grade Filter is fed to the Cartridge filter to remove the remaining suspended materials and also the chemical components present in the water.

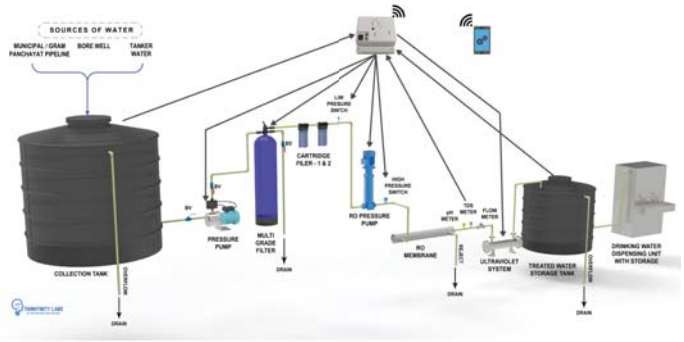

Fig. 7. Device controlling various meters

The system then automatically turns on the low pressure switch to push the water from the cartridge filter to the RO pressure pump, the system turn on the RO pressure pump and has the capability to control the pressure in the RO pump. Once the water reaches the the RO pressure pump then the system opens the High pressure switch where in the water in pumped with the high pressure to the RO membrane to completely eliminate the total dissolved particles present in water.

The water from the RO membrane will flow thorough the series of meters to measure the various parameters. Three meters have been used in the filtration process they are pH meter, TDS meter, and Flow meter. when the water flows through the pH meter its reads the pH value of the water. Next, the water flows through the TDS meter as it measures the total dissolved solids in the water. In general during the reverse osmosis process the RO membrane will totally eliminate the TDS from the water. Water with zero TDS value is not good for health, hence based on the TDS threshold value the system reads the threshold value and if the value is less than the threshold limit it automatically adds the required amount of solids through peristaltic pump and this process is called

”Dosing”. Then the water flows through the flow meter were in flow pressure of the water is controlled based upon the flow rate the water is the flow through the ultraviolet system in this process the germs are eliminated by UV light. The finally treated water is then stored in the treated storage tank.

All the meters and valves are controlled by the designed system and an android application has been integrated with the system to monitor and control process through manually or remotely. The readings from the various meters are can be read through the system or through the android application and necessary actions can be taken based upon the situation.

IV. Results and Discussion

The fig 8. shows the main power supply of the water filtration and yellow color highlighted box indicates the designed system that has been integrated with the main system to control and monitor the various parameters.

Fig. 8. RO Connect With Water Purification Process

When the filtration process starts the designed system will automatically calculate the amount of TDS present in water in terms of ppm, the flow rate of the water in term of LPH, and the pH value of the water

Fig. 9. Display With Various Parameter Values

V. Conclusion

The main aim of the designed system is to measure the TDS value, water flow and pH value during the process of filtration. The values that are read from the system will be displayed on the screen and in parallel the readings will be sent to the android application. Based upon the values if there are any changes the we can change the system configuration through manually or remotely. The system is user friendly , it can be detached from the purifier when it is not in use and can be attached to new purifier commonly know as Retro fitting. The system also has the capability to identify the damages in the purifier and will automatically identify the damage and raise a ticket to the support team with the detailed description.

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