INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 Oct-Sep 2019 – www.ijrmmae.in – Pages 103-109

ADAPTIVE SEQUENCING BASED MINERAL MANAGEMENT IN WATER AND TDS MONITORING USING ARDUINO

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ABSTRACT - The purpose of this project is to design a water purification system that can retain the essential minerals from any source of water, making it valuable for drinking and other domestic purposes. The motivation for this project is the drawback in RO system is that significantly reduce these good minerals and it promotes water wastage. Our goal is to design a system that retain the minerals on purification process and efficiently provide pure water. The system utilizes sediment filter, carbon filer, alkaline filter supplemented with ultraviolet light to effectively filter and sterilize contaminated water as it is pumped to the reservoir. The system comes with Arduino microcontroller, which acts as central control unit that implement coagulation and flocculation chemical treatments with sequential control of filter stage, monitoring the TDS level and decrease the output water delivery time. Clean water is not available in all parts of the world. Many people live with polluted water that is unhealthy to drink and bath . Water purification is the process by which undesired chemical compounds, organic and inorganic materials, and biological contaminants are removed from water. One major purpose of water purification is to provide clean water but today scenario on purification system has made the people to re-examine the health quality of the water provided by the modern water purifying systems. Typical steps for full water treatment include aeration, coagulation, sedimentation, filtration and disinfection. Most purification system come with RO system which filters the contaminated water by passing it through the permeable membrane that is capable of allowing only the water molecules and rest of the contamination and even essential minerals are filtered, which does not add value to the water, By Providing and sequencing the right filtering stage and elimination of RO system promote retaining mineral and also give pure water.

KEYWORDS: UV filter, TDS, Arduino, Adaptive sequencing method

I. INTRODUCTION

Our objective is to develop the management system for minerals in water and continuous monitoring of TDS level. The technology will decrease the output water delivery time. RO water purifiers use a membrane that acts as a barrier between impure water and pure water. Impure water molecules don't pass through the membrane. The molecules of the membrane are much smaller compared to the molecules of germs and bacteria. This ensures that they can't pass through the RO membrane. They are then filtered out of the system. A search on Google to find which country has banned RO water or RO water purifier yielded results in which not even a single country is named. So no country has banned the use of RO water nor RO water filter purifiers. But recently the National Green Tribunal of India, a body set up by an Act of the Indian Parliament which enables it to quickly dispose of the cases pertaining to environmental issues, ordered that RO purifiers should not be used in areas of New Delhi, India where the TDS (Total Dissolved Solids) of public water supply is less than 500 ppm.

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This order was challenged in the Supreme Court of India, but on 22 November 2019 the Supreme Court refused to stay the order of the National Green Tribunal which prohibited the use of RO water purifiers in areas of Delhi where the TDS less than 500 per litre. I support the Greens in almost all their campaigns, but their campaign for banning RO water purifiers is counter productive and I am against it. With all this bad publicity about RO water purifiers, I am going to stick my neck out and say that RO water filter purifiers are the best thing that has happened in the field of water purification, especially in domestic drinking water purifiers. RO is a very effective way of making sure our drinking water remains pure in this age of rampant uncontrolled pollution all around our country. RO water purifiers are cursed by many people because of the following problems:

- Gives distilled quality water without any minerals which can be harmful to health.
- Gives acidic water which may not be good for health.
- Wastes water.

II. REVIEW OF LITERATURE

2.1 Activated charcoal: preparation, characterization and application

Applications of Activated Carbon (AC) Applications of AC are enormous. Its important use is for gasoline vapor emission control canisters in automobile.AC can act as a filter material in air cleaning filters for removal of gases and vapors in the industrial environment. Especially impregnated grades are used in cigarette filters to adsorb some of the harmful components of tobacco, and as the catalyst or carrier of catalytically active substances. Heavy metal ions such as mercury, lead and cadmium in drinking waters are very dangerous even in trace amount, and adsorption method for removing these ions can be essential for water and waste water contaminated by heavy poisonous metal ions. For example lead, cadmium, mercuric ions all are very toxic and carcinogenic. Lead is also a cumulative metabolic poison, acting as a mutagen when adsorbed in excessive amounts. These ions cannot be removed from water with classic physical or chemical treatments completely. Activated carbon can be used for removal of poisonous heavy metal ions from aqueous solutions. Adsorption in this case is due to the surface complex formation between the metal ions and the acidic surface function group of AC. Adsorption is due to the surface complex formation between the metal ions and the acidic surface function group of AC. The removal efficiency is influenced by various factors, such as solution concentration, solution pH, ionic strength, nature of adsorbate, adsorbent modification procedure, Physical properties (surface area, porosity), and the chemical nature of AC.

2.2 UV radiations

Ultraviolet or UV energy is found in the electromagnetic spectrum between visible light and x-rays and can best be described as invisible radiation. In order to kill microorganisms, the UV rays must actually strike the cell. UV energy penetrates the outer cell membrane, passes through the cell body and disrupts its DNA preventing reproduction. UV treatment does not alter water chemically; nothing is being added except energy. The sterilized microorganisms are not removed from the water. UV disinfection does not remove dissolved organics, inorganics or particles in the water. The degree of inactivation by ultraviolet radiation is directly related to the UV dose applied to the water. The dosage, a product of UV light intensity and exposure time, is measured in microwatt second per square centimeter (mws/cm2). The accompanying table lists dosage requirements to destroy common microorganisms. Most UV units are designed to provide a dosage greater than 30,000 mws/cm2 after one year of continuous operation. Notice that UV does not effectively disinfect some organisms (most molds, protozoa, and cysts of Giardia lamblia and Cryptosporidium) since they require a higher dose.

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2.3 REVIEW ON WASTEWATER TREATMENT TECHNOLOGIES

A functional and sustainable wastewater management scheme begins at the household level and is largely dependent on the "software" or the human component (Khouri et al., 1994). Only when perception of need and perhaps, anticipation for a wastewater reuse system has been internalized at the neighborhood/user level, will planning and implementation be successfully executed (Khouri etal., 1994). Local level support of a treatment and recovery scheme can, in turn, catalyse pro-active institutions and vertical support from governments. Once the software component has been integrated project development, the "hardware" or technological component can act to promote a comprehensive, integrated, and sustainable wastewater treatment and recovery strategy for the community - if it is well selected and "appropriate". Several features characterise an appropriate wastewater treatment technology that can be a sustainable amenity to a community. Denny, (1997) has stated that wastewater treatment technologies in the developing world must have one overriding criterion: the technology must be cost-effective and appropriate. In this literatures it is understood that how the waste water's contaminants are washed out by large scale and medium scale techniques that are been used in various countries.

- Application of Active carbon in water purification.
- The effluent reactions which takes place in water and its harmful effects are studied.
- Effects of ultra violet radiation on microorganisms.
- Technical analysis over flocculants and turbidity.

2.4 COAGULATION AND FLOCULATION

One of the first of the several steps that municipal water suppliers use to prepare water for distribution is getting it as clear and as particulate-free as possible. To accomplish this, the water is treated with aluminum sulphate commonly called alum, which serves as a flocculent. Raw water often holds tiny suspended particles that are very difficult for a filter to catch. Alum causes them to clump together so that they can settle out of the water or be easily trapped by a filter.Usually a mixture of water with 48 percent filter alum is injected into the raw incoming water at a rate of 18 to 24 parts per million. The alum promotes coagulation of fine particles which helps resolve problems of color as well a turbidity. If the process is given enough time to work and is applied properly, it not only corrects problems in the water but actually results in removing most of the aluminum used in the process. Although concern over the safety of treating water with aluminum has often been voiced, there is no evidence that aluminum in water, whether it comes from the aluminum sulphate used in treatment or from other sources, is a health issue. Most aluminum intake is from aluminum that occurs naturally in foods, aluminum used in food packaging, and from products like deodorants and vaccines. There are a variety of primary coagulants which can be used in a water treatment plant. One of the earliest, and still the most extensively used, is aluminum sulphate, also known as alum. Alum can be bought in liquid form with a concentration of 8.3%, or in dry form with a concentration of 17%. When alum is added to water, it reacts with the water and results in positively charged ions

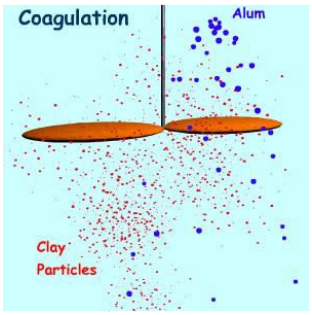

Fig 1: Flocculants Capturing Clay Particles

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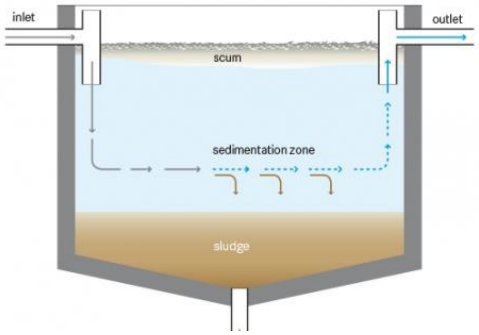

Fig 2: Flocculants treatment

Coagulation/flocculation is a process used to remove turbidity, color, and some bacteria from water. In the flash mix chamber, chemicals are added to the water and mixed violently for less than a minute. These coagulants consist of primary coagulants and/or coagulant aids. Then, in the flocculation basin, the water is gently stirred for 30 to 45 minutes to give the chemicals time to act and to promote floc formation.

The floc then settles out in the sedimentation basin. Coagulation removes colloids and suspended solids from the water. These particles have a negative charge, so the positively charged coagulant chemicals neutralize them during coagulation. Then, during flocculation, the particles are drawn together by van der Waal's forces, forming floc. The coagulation/flocculation process is affected by pH, salts, alkalinity, turbidity, temperature, mixing, and coagulant chemicals Aluminum sulphate is widely used as a flocculent in water treatment plants in developing countries. It is also widely available in developing countries, sold in blocks of soft white stone, and generally called alum. There are numerous ways to use alum as a flocculent, including to crush it into a powder before adding it to water, stirring and decanting or stirring the whole stone in the water for a few seconds and waiting for the solids to settle. The benefits of alum are that it is widely available, is proven to reduce turbidity, and is inexpensive. The drawback of alum is that the necessary dosage varies unpredictably. Laboratory studies have shown that alum is effective at reducing turbidity and chlorine demand.

2.5 FILTER STAGES

A sediment filter captures and removes particulate matter like dirt and debris from your water. Sediment is a generic term for all the particulate matter in your water that is not liquid.

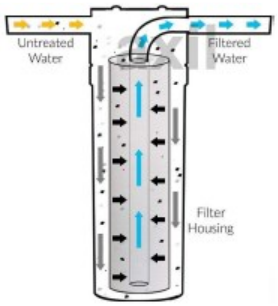

Fig. 3. Filter

Flakes of rust can enter your water supply from corroded galvanized plumbing. Rainwater can carry silt, clay, soil, and grains of sand into your well groundwater supply. Flow changes in your water main can also transport sediment to your home. The sediment filter is the first line of defense against this dirt and debris. It prohibits all this solid particulate from entering your water supply and impeding the performance of your water filtration systems. Sediment filters work through a process called mechanical filtration.

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Mechanical filtration physically blocks unwanted particulate matter from infiltrating your water supply sediment filters have enough porosity to allow water to flow into your home but can capture the dirt and sand the water is carrying. Sediment filters are the net that catches the particulate matter traveling in your water sediment filters remove visible particulate matter, and any particles of dirt, sand, dust, and debris that can be caught by its micron-rated capacity. Sediment filters also remove turbidity from water. Turbidity is the cloudiness caused in water by the heavy presence of suspended solids. This causes water to turn yellow, orange, or brown. Sediment filters do not remove chemicals, heavy metals, bacteria, or dissolved particulate matter. They do not improve the taste or smell of water. They are primarily a defensive and preservative filtration method. Sediment filters are most effective when serving as prefilters for other filtration systems.

III. DESIGN

3.1 3D MODELLING

The SOLIDWORKS® CAD software is a mechanical design automation application that lets designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings and computer-aided engineering (CAE) computer program that runs on Microsoft Windows.

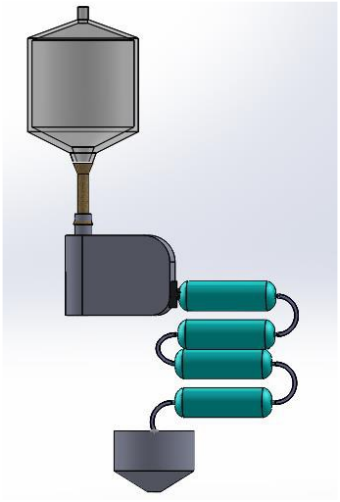

Fig 4: Assembled view of Tank, Sediment Pipe, Pump, Filter Stages,Reservoir

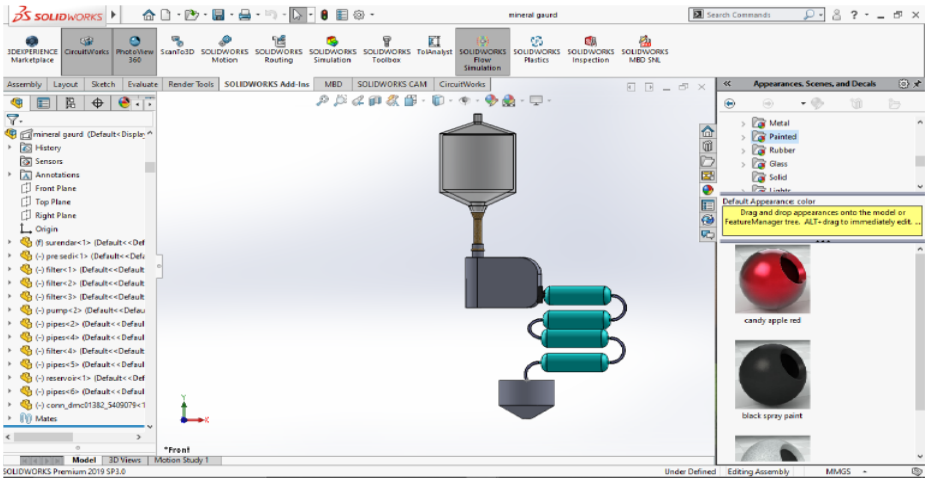

Fig 5: Design using solidworks

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3.2 COMPONENTS CONNECTION:

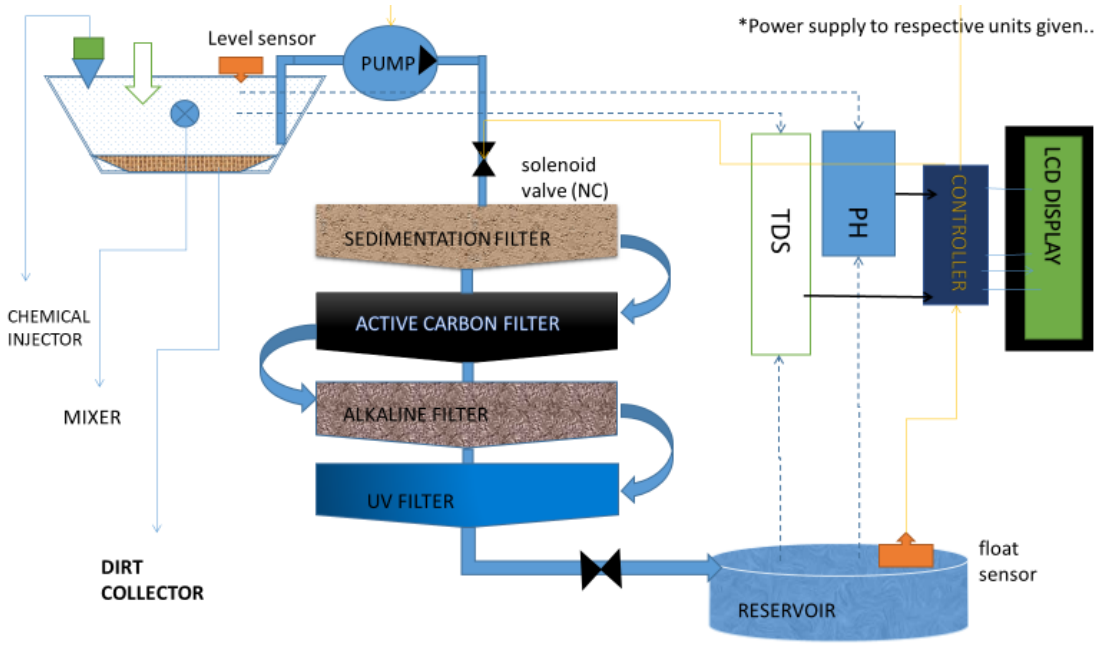

FIG 6: Process Flow Diagram

STAGE 1: The contaminated water is collected in the tank A on defined limited quantity, which can be sensed by the water level sensor attached to the Tank A. The limit for Tank A is 5 liters, and then the collecting of contaminated water was stopped by actuating the solenoid valve, which can be automatically done by the Arduino UNO Microcontroller.

STAGE 2: In the next step, the flocculants (Alluminium sulphate) of 5grams is added to the Tank A, which contaminated water is stired for some duration by actuating a DC motor connected to stir rod, the mixture is allowed for flocculation and coagulation process. Coagulation /flocculation is a process used to remove turbidity, color, and some bacteria from water. In the flash mix chamber, chemicals are added to the water and mixed violently for less than a minute and waiting for the solids to settle and gets collected in the dirt collector.

STAGE 3: Now the clear water, is pumped to the filtration stages by the pressure booster pump to the sedimental filter, which captures and removes particulate matter like dirt and debris from your water.

STAGE 4: Next stage is the active carbon filter, . Eliminating organics in potable water, such as humic and fulvic acid, prevents chlorine in the water from chemically reacting with the acids and forming trihalomethanes. In addition, heavy metals, such as lead, can be removed.
STAGE 5: Alkalime filter stage enhance the minerals to the water by oxidation and reduction reaction.

STAGE 6: UV filtration stage, disinfects biologically unsafe water (lake water, seawater, well water, etc.) without using any chemicals.

STAGE 7: The final output water will be valuable for drinking and also retains minerals, and stored in TankB (reservoir),the reservoir also contains the level sensor that sense the level of the water in tankB, and when it is full the pump and the uv lamp power supply is stopedand goes to power saving mode.

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IV. IMPLEMENTATION

Microcontroller based hardware and software is designed to make existing water purifiers real time monitoring system. The system utilizes sedimental filter, carbon filer, alkaline filter supplemented with ultraviolet light to effectively filter and sterilize contaminated water as it is pumped to the reservoir. The system comes with Arduino microcontroller which act as central
control unit that implement coagulation and flocculation chemical treatments with sequential control of filter stage, monitoring the TDS level and decrease the output water delivery time. The development and implementation of water treatment technologies have been mostly driven by three primary factors: the discovery of new rarer contaminants, the promulgation of new water quality standards, and cost.As of to the recent trend and growth in Water treatment and
plantation field it requires many ideas and strategies to go further to meet the needs, So this project will be implemented as a testing product to check and analyse the desired quality standards.

V. CONCLUSION

So as per our goal off this project, we designed a dependable way to purify water for the location for those are off grid and don't have constant sources of clean water. TDS value obtained from the prototype is compared with lab values obtained from environmental lab using chemical process and standard TDS meters available in the market and all the readings gave similar results. This design also fulfil the requirements of low budget product ,this model will be a complementation of Conventional water purifier system and it will subjected to the succeeding features like Penta Purification process, In tank UV sterilization ,DIY filter replacement, Easy to clean, 5 liter capacity, Real-Time TDS Monitoring, real time filter life monitoring, Auto water level detector. This model aim is to retain the minerals and detain the pathogens that present in the water, So that an highly quality water will be a output from the system.

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