IoT based Sewage Water Management using Solar

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***Abstract* - Water, energy, and food are essentials for a growing global population, and their security is now one of the most pressing global challenges. For the treatment of sewage water, numerous methods including physicochemical, biochemical, and combination treatment methods have been established with notable treatment efficiency by numerous investigators. In this work, solar desalination and PV-based electrolysis are used to treat sewage water. The sewage water treatment system based on solar energy performs better than other traditional techniques. Energy backup batteries with PV were implemented to make the most of three units.**

Keywords: Sewage water management, Solar PV, IoT based Monitoring, Renewable energy-based treatment

I.INTRODUCTION

In many regions around the globe, all major rivers are either in extremely bad condition or are suffering a moderate to severe water deficit due to the rising production of sewage water. Municipal water quality is impacted by population expansion, whereas commercial water quality diminishes as industrialization quickens. Because developing countries don't have access to as much advanced technology as affluent countries do, these problems are getting worse. India, one of the world's top developing nations, uses 50 to 200 MLD of water per person on average, both in urban and rural areas. The methods for treatment need a lot of conventional energy, increasing both the carbon footprint and the need for energy globally (Bhawan and Nagar, 2020). 60 to 70 percent of the water provided for domestic consumption is transformed into sewage water, according to the Central Public Health and Environmental Engineering Organization (CPHEEO). In India, 35,558 MLD of freshwater and 2,696 MLD of sewage water are produced.

The technological solutions for treating sewage water (activated sludge, trickling filters, membrane filters, reverse osmosis, etc.) are inefficient and use a lot of energy. The construction of a sewage water treatment facility is expensive and energy-intensive. Chemical treatment of sewage water is quick but has negative environmental effects while biological treatment is a long procedure (Kaewkannetra et al., 2011, Park et al., 2012). The current renewable energy generation technologies (such as solar, wind, and hydro) are location and dependent on the local climate. The cost of energy transmission rises as a result of site specifications (Feng et al., 2011). To tackle the issues with sewage water treatment, on-site (standalone) treatment technology is necessary.

The traditional approach for treating sewage water from urban plants often uses an activated sludge technique, which is neither economical nor energy-efficient. There are many methods available that can improve the removal of contaminants from sewage water. Ozone generation, magnetic nanoparticles (MNPs), UV light, activated carbon, and lime soda process are some of these methods.

- Renewable energy-based treatment technologies

Over the past few years, different renewable energy technologies like wind, hydro, solar, biomass, waste to energy etc. are in focus. Among all the available renewable energy technologies solar technology is reliable due to availability of solar radiation throughout the world whereas other renewable energy based technologies are site specific. Solar energy is available in most of the regions in India and has a huge potential to promote the development of technologies. Solar energy finds its application in two major areas i.e., solar photovoltaic and solar thermal. Solar thermal energy-based technologies extract heat energy which can be used in solar desalination and solar photo-catalyst. Thus, solar technologies for sewage water treatment applications are categorized into two categories: (a) Solar PV based electrolysis and (b) solar thermal energy based treatment.

Renewable energy sources especially solar energy can be better to fulfill the potable water and hot water demand, especially solar energy (Smyth et al., 2019). Solar energy can be utilized in both forms i.e., thermal and electricity for potable water and hot water production. Solar still is the oldest and simplest methods for treating unhealthy water through the evaporation method (Narayanan et al., 2020). Solar still is an ecofriendly, economically viable, developed, operated, maintained and proves to be a solution for treatment of saline/brackish water. This technology only requires solar energy and less workforce to manage and can be an attractive solution for developed, developing and underdeveloped countries for fresh water supply (Madiouli et al., 2020). The technology is now at an advanced stage that it can be used at the village level, remote locations and industrial sewage water treatment. The main drawback of such a system is their low productivity, which is the main area to work on, different researchers are working on integration of external systems and modification of solar stills. Although, solar thermal collectors are the most attractive solution for water heating applications (Pugsley et al., 2019) and in combination with solar still for potable water production.

- Solar PV Based Treatment Technologies

Hydrogen is produced by solar electrolysis using solar photovoltaic panels, and it has a substantial amount of energy when compared to natural gas or a combination of the two. According to Ursua et al. (2011), electrolysis produces hydrogen that is 99.99 vol% pure. Solar energy can be used in two different ways to produce hydrogen in sewage water industries: (i) direct water electrolysis; and (ii) using solar-powered electricity to electrolyze water into hydrogen. According to the available literature, studies on direct water electrolysis are more prevalent than those on the second method of hydrogen synthesis combined with solar energy (Boretti, 2020, Schmidt et al., 2017).

In solar thermal treatment technologies, solar still application is proving to take a significant way for the treatment of domestic and industrial sewage water. The solar still are used for sewage water or seawater desalination which is highly polluted or saline in nature respectively. This technology has potential for portable water supply in villages, ships, and an area nearby the sea due to its non-dependence on conventional energy for its operation. Presently work is ongoing on the use of concentrator-based systems for solar still to increase efficiency and distillate water productivity.

II. LITERATURE REVIEW

McLoughlin et al. (2004) conducted an experiment for the wastewater treatment process with E. build a 3 m2 reactor with a 1 m2 lighted surface made up of non-tracking compound parabolic collectors for the E. coli K-12 species. Titanium dioxide (TiO2) suspensions with levels ranging from 0 to 9 mg/L were also used in the tests. The outcome includes that E.

Manariotis and Chrysikopoulos (2012) worked on the performance of anaerobic bioreactor with the help of designed solar system for heating the packed bed reactor to enhance the feasibility of the system. This study was to fill the reactor with solar-heated warm water and increase the temperature to close to 35 °C, which is beneficial for anaerobic processes year-round. According to the model, the heat demand of the reactor may be effectively balanced by varying the number of flat plate solar collectors that continuously feed warm water that is over 20°C. As a result, the suggested approach may present an effective substitute for improving anaerobic treatment in water treatment facilities.

The solar still was divided into two categories by Chandrashekara and Yadav (2017): (1) direct solar radiation collection and (2) indirect solar radiation collection. Rufuss et al. (2016) called it a passive and active solar still, and Kumar et al. (2015) divided it into single-effect type and multi-effect type solar stills. Several sorts of solar stills are categorised based on how heat from the sun or any other source (indirectly) that can be produced by various solar collectors causes the water to evaporate (Kumar et al., 2015). For the large-scale treatment of water, the economical and effective technology has not yet been fully realised (Arjunan et al., 2014).

Dual passage solar air absorber was used in the study carried out by Kabeel et al., 2016, together with his colleagues. Moreover, PCM has been used to store thermal energy. Between June and July, the suggested system was tested in the climate of Egypt. The results showed that the traditional still only generated 4.5 L/m2 per day. The same meteorological conditions were used to compare the two systems. Also, it has been claimed that the improved technique is 108% more effective than a standard still.

METHODOLOGY

The four specific goals for the current investigation are described in this proposed methodology: I overview of the design; (ii) sewage water collection; (iii) process efficiency; and (iv) contaminant extraction efficiency.

Figure 3.1 Sewage Water Management

The electrolysis process, which separates water into oxygen (O2) and hydrogen (H2) gas, is carried out using an electrochemical apparatus. Water can be separated from one another. Given by is the overall electrolytic response

The alkaline electrolytes produced the best results. Here is how the electrolytic unit's internal response might be described:

Metal electrodes are used as the anode and cathode in these processes. The creation of a coagulant at the anode of metal ions utilised as the anodic material causes the coagulation step to take place when the voltage is supplied to both electrodes. Hydrogen and hydroxyl ions are produced at the cathode, which causes coagulated substances to float.

Figure 3.2 Proposed System Architecture

Figure 3.3 IoT based Monitoring

- IoT based Monitoring

It is made up of an ultrasonic sensor, a flow sensor, and a float sensor in addition to a NodeMCU ESP2866 and an Arduino Uno. A power supply is essential for both NodeMCU and Arduino. The NodeMCU device will be linked to the android application.

NodeMCU Esp8266

It is a low-cost internet of things platform that uses open source software. Both the open-source NodeMCU microcontroller and the development board that it comes with are created with Internet of Things applications in mind primarily. It is the primary component of the system that is being suggested, and the ultrasonic sensor as well as the blynk web app are connected to it.

Solar Panel

The significant performance data of the solar assets, such as performance loss, energy usage, outages, failures, etc. that result in generation loss, are monitored and tracked centrally and remotely by solar monitoring systems. The controller receives information about the actual tilt position of the solar modules from the inclination sensor of a solar panel system. Even in challenging environmental circumstances, the line of inclination sensors offers non-contact inclination measurement with precision. The sensors offer high availability with fully encased circuitry and can be used for one- or two-dimensional measurements.

Arduino UNO

A diversity of electronic applications can use this open source programmable microcontroller board since it is reasonably priced, adaptable, and easy to use. It is another essential component of the system that will be designed, and it is the point at which the flow sensor and the float sensor will be connected.

pH Sensor

The microbial composition of a wastewater system is significantly influenced by pH. The bulk of our typical environmental microorganisms flourish in the pH range of 6.5 to 8.5, where the majority of biological wastewater treatment is carried out.

Float Sensor

The float level sensor is a type of continuous level sensor that consists of a magnetic float that adapts its position in response to changes in the liquid level. A float sensor is connected to an Arduino Uno in the system that has been presented in order to provide users with an alarm when the level of sewage in the tank approaches the limit that has been set for it.

A float sensor is used to determine whether or not the level of sewage inside the tank has reached the predetermined limit. In addition, the flow sensor is capable of analysing the flow of effluent. Workers in the sewage system are alerted by a blynk if the level of sewage in the system reaches the predetermined threshold value. This indicates whether or not it is necessary to clean the wastewater. This system enables the monitoring of sewage level using an ultrasonic sensor, the monitoring of sewage flow rate using a flow sensor, and the receipt of a signal when the sewage level reaches a predetermined threshold, thereby assisting sewage workers in making important decisions for cleaning and maintaining a disease-free environment.

IV. RESULTS AND DISCUSSION

The experimental results are presented and discussed. Laboratory tests reveal the characterization of municipal sewage and water treatment plant with solar PV based electrolysis process.

Figure 4.1 DC Voltage Converter

Figure 4.2 DC Voltage Converter with Solar Panel

Figure 4.3

Figure 4.4 Water Quality Monitoring App

V. CONCLUSION

In-depth research to ascertain the technique's full potential is warranted given the growing interest in electrochemical processes as a potential solution to enhance, if not entirely replace, current technologies for wastewater recovery. This study examines the creation of hydrogen utilising two distinct types of electrodes, such as organic and inorganic, using a solar PV-based electrolysis method and sewage water treatment. The sewage water treatment system based on solar energy performs better than other traditional techniques. Energy backup batteries with PV and Phase Change Materials (PCM) integration were implemented to make the most of three units. IoT sensor is utilised in the monitoring of the wastewater float sensor, which determines whether or not the quantity of sewage contained within the tank has reached its threshold.

REFERENCES

[1] Ivars-Barceló F, Zuliani A, Fallah M, Mashkour M, Rahimnejad M, Luque R. Novel Applications of Microbial Fuel Cells in Sensors and Biosensors. *Applied Sciences*. 2018; 8(7):1184. https://doi.org/10.3390/app8071184

[2] Kang Mao, Hua Zhang, Yuwei Pan, Zhugen Yang, Biosensors for wastewater-based epidemiology for monitoring public health, Water Research, Volume 191, 2021, https://doi.org/10.1016/j.watres.2020.116787

[3] Abrevaya, X.C., Sacco, N.J., Bonetto, M.C., Hilding-Ohlsson, A. and Cortón, E. (2015) Analytical applications of microbial fuel cells. Part I: biochemical oxygen demand. Biosens Bioelectron 63, 580– 590.

[4] Chouler, J. and Di Lorenzo, M. (2015) Water quality monitoring in developing countries; can microbial fuel cells be the answer? Biosensors 5, 450– 470.

[5] Wang Z, Li D, Shi Y, Sun Y, Okeke SI, Yang L, Zhang W, Zhang Z, Shi Y, Xiao L. Recent Implementations of Hydrogel-Based Microbial Electrochemical Technologies (METs) in Sensing Applications. Sensors. 2023; 23(2):641. https://doi.org/10.3390/s23020641

[6] Wang, J.; Zhao, S.; Kakade, A.; Kulshreshtha, S.; Liu, P.; Li, X. A Review on Microbial Electrocatalysis Systems Coupled with Membrane Bioreactor to Improve Wastewater Treatment. Microorganisms 2019, 7, 372.

[7] Na Chu, Qinjun Liang, Wen Hao, Yong Jiang, Peng Liang, Raymond Jianxiong Zeng, Microbial electrochemical sensor for water biotoxicity monitoring, Chemical Engineering Journal, Volume 404, 2021, https://doi.org/10.1016/j.cej.2020.127053.

[8] Pendharkar, Anushka & Chillapalli, Jyothi & Dhakate, Kanksha & Gogoi, Subhalaxmi & Jadhav, Yogesh. (2020). IoT based Sewage Monitoring System. SSRN Electronic Journal. 10.2139/ssrn.3697395.

[9] G Chandhini, B Chithra, P Kiruthikadevi, Bhagya Sasi, V. Kamal Kumar, "IoT Based Underground Drainage Monitoring System", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878 (Online), Volume-9 Issue-3 September 2020

[10] B. Sumathy, G. Gowthaman, K. Hari Haran, G. Keerthee Rajan, A. Sweeto Jeiso, "Sewage Level Maintenance Using Iot", International Journal of Mechanical Engineering and Technology (IJMET) Volume 9, Issue 2, February 2018, pp. 389–397

[11] Anushka Pendharkar, Jyothi Chillapalli, Kanksha Dhakate, Subhalaxmi Gogoi, Yogesh Jadhav, "IoT based Sewage Monitoring System", Conference Paper in SSRN Electronic Journal · October 2020

[12] Priya Tiwari, "IoT Based Smart Sewage Monitoring System using GSM and Wi-Fi Module", International Journal of Innovative Science and Research Technology, Volume 6, Issue 5, May – 2021

[13] Samiha Sultana, Ananya Rahaman, Anita Mahmud Jhara, Akash Chandra Paul, Jia Uddin, "An IOT based Smart Drain Monitoring System with Alert Messages", 2021, DOI:10.1007/978-3-030-68452-5_9

[14] Muhammed Sakib Hasan, Shahjalal Khandaker, Md. Shahid Iqbal, Md. Monirul Kabir, "A Real-Time Smart Wastewater Monitoring System Using IoT: Perspective of Bangladesh", 2020 2nd International Conference on Sustainable Technologies for Industry 4.0 (STI), 19-20 December.

[15] Rony, J.H.; Karim, N.; Rouf, M.A.; Islam, M.M.; Uddin, J.; Begum, M. A Cost-Effective IoT Model for a Smart Sewerage Management System Using Sensors. J 2021, 4, 356–366. https://doi.org/10.3390/j4030027