International Journal of Research in Engineering, Science and Management
Volume 5, Issue 4, April 2022
https://www.ijresm.com | ISSN (Online): 2581-5792

Treatment of Sewage by Pulse Ultrasound Sonication

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***Abstract*: Nowadays there are various sources & types of waste water and it increase the treatment cost and process of the effluent if not treated or stored in a Systematic manner. The sewage water is also becoming hot topic and it needs to be treated to reduce the parameters and impurities to make it reusable or recycled. For that the waste water must be segregated and stored separately. Sonication method will be used to treat the Sewage water. Sewage water will be treated using pulse ultra sound technology. Number of analysis of the effluent will be done in the Ultra Sonic Chamber and at specific conditions. The percentage removal of various parameters such as chemical oxygen demand (COD) and Turbidity will be observed and studied. It will become necessary to treat all kind of waste separately and efficiently as the Environmental awareness is increased to sustain the Ecosystem for the future too.**

***Keywords*: Sewage water, Pulse sonication, Treatment, COD, Turbidity.**

1. Introduction

The interest on alternative water sources has increased incredibly during the last several years due to scarcity of fresh water. Due to up scalation in population and industries fresh water has played major role in anthropogenic activity, Therefore the need of water conservation practices increases. To decrease the water demand from the available water resources, the novel treatment methods has been applicable for the treatment and reuse of wastewater.

Sewage water is wastewater from people living in a community. Sewage consists of wastewater discharged from residences and from commercial, institutional and public facilities that exist in the locality. Mostly, sewage water consists of grey water and black water. Grey water is the waste water from washing either from bathing, dishes or laundry. Black water is the wastewater from toilets. It is characterized by debris such as paper wrapping, sanitary products, soap residues, and dirt due to the chemical composition of the various waste materials. Sewage water has a foul smell.

The main parameters in sewage that are measured to assess the sewage strength or quality as well as treatment options include: solids, indicators of organic matter, nitrogen, phosphorus, and indicators of feral contamination. Sewage contains pathogens which stem from feral matter. The following Four types of pathogens are found in sewage: pathogenic bacteria, viruses, protozoa and helminths.

An estimated 62,000 million litres per day (MLD) sewage is generated in urban areas, while the treatment capacity across India is only 23,277 MLD, or 37% of sewage generated, according to the data released by the government in 2015.Treated sewage water can be used many different purposes like farm forestry, horticulture, toilet flushing, industrial use, fish culture, indirect and incidental uses.

Several physical, chemical and biological treatment has been adopted in the last few years for treatment and reuse of sewage water. Physical treatments include sand filtration, adsorption, and membrane filtration. Chemical treatments include coagulation, ion exchange and biological treatment include membrane bioreactor, constructed wetland, SBR, MBBR. In recent years, several advanced oxidation processes (AOPs) have been widely used for the treatment of various types of industrial and domestic wastewater. AOPs based processes are trending approach, which can be used for the complete mineralization and degradation of heavy and complex organic pollutant. AOPs such as electrochemical oxidation, Fenton's oxidation, photo Fenton, Ozonation, Cavitation/Sonication were used.

A. Pulse Ultrasound Sonication

Sonication is the act of applying sound energy to agitate particles in a sample, for various purposes such as the extraction of multiple compounds from plants, microalgae and seaweeds Ultrasound refers to mechanical vibrations, which are essentially the same as sound waves but of a higher frequency. Such waves are beyond the range of human hearing that's why it called ultrasonic. The range of ultrasound is greater than 20000 Hz. Sonic waves are series of mechanical compressions and rarefactions in the direction of travel of the wave. They can occur in solids, liquids, and gases by regular compression and separation of molecules. As sound waves pass through any material their energy is dissipated or attenuated. The molecules of all matter are in constant random motion. The amount of molecular agitation is measured as heat (greater the molecular movement, greater the heat).

$$H_2O + \text{Sound energy} \longrightarrow {}^{\bullet}H + {}^{\bullet}OH$$

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Sonication has numerous effects, both chemical and physical. The chemical effects of ultrasound are concerned with understanding the effect of sonic waves on chemical systems, this is called Sonochemistry.

Sonication can be used for the production of nanoparticles, as well as for wastewater purification, extraction of seaweed polysaccharides and plant oil, extraction of antioxidants, production of biofuels, crude oil desulphurization, cell disruption, polymer and epoxy processing, adhesive thinning, and many other processes. It is applied in pharmaceutical, cosmetic, water, food, ink, paint, coating, wood treatment, metalworking, Nano composite, pesticide, fuel, wood product and many other industries. Soil samples are often subjected to ultrasound in order to break up soil aggregates; this allows the study of the different constituents of soil aggregates. Continuous Ultrasound: Continuous delivery of Ultrasound throughout the treatment period. Pulsed Ultrasound: Delivering Ultrasound only during apportion of the treatment period. Transducer is the device which generates ultrasound wave. It is used to convert an electric signal into ultrasonic energy.

The present study focusses on the treatment of sewage water using pulse ultrasonication. The parameters like pH and time variation were done in the presence of catalyst.

B. Objective

The objective of the study was to Check the performance and efficiency of Pulse Ultrasound Sanitation for the treatment of sewage water.

C. Scope

The study majorly focuses on to the reduction of COD and Turbidity of sewage water by Pulse Ultrasound Sanitation method.

Treated sewage water can be used for many different purposes like arm forestry, horticulture, toilet flushing, industrial use, fish culture, indirect and incidental uses.

Due to overpopulation in urban areas without proper planning, it has resulted in Sewage pollution, which poses a threat not only to the environment but also to human health. It also affects biodiversity, aquatic life, agriculture, and is a major contributor to eutrophication and increase in Biological Oxygen Demand (BOD).

The treatment of sewage water is a trending Strategy to reduce the treated fresh water from the ultimate urban consumption.

The current Demand for treatment of sewage water as an environmental issue.

Sewage water reuse has been considered as a reliable method of ensuring water security as compared to other methods of water capture such as rainwater harvesting which is dependent on hydrological conditions.

2. Study and Summary of Literatures

Combined Hydrodynamic cavitation Based processes as an efficient treatment option for real industrial effluent. (Pooja Thanekar, Parag R. Gogate)

In the present work, hydrodynamic cavitation (HC) operated alone and in combination with chemical oxidants has been applied for the treatment of real industrial effluent obtained from a local industry. The HC operated individually and in combination with oxidation processes based on hydrogen peroxide (H2O2), ozone (O3) and persulphate (KPS). Subsequently, the treatment of real industrial effluent has also been investigated in details using HC alone and in combined mode with other oxidation processes focusing on the main objective of COD reduction.

- They study that at Power 120W, 20kHz frequency, at 30 °C temperature, pH 2, time duration 120min for 7sec on & 3sec off. 5 g/l H2O2.
- It has been observed that only 10.6% as the COD reduction was obtained using only ultrasound treatment for 120 min. The approach of US/H_2O_2 resulted in much higher COD reduction as 60.0%, which can be explained on the fact that the ultrasound favours the dissociation of H_2O_2 leading to the higher quantity of hydroxyl radicals. Also, the combined operation of US/O_3, US/H_2O_2/O_3 and US/ KPS gave higher COD reduction as 20%, 61.8%, and 19.2% respectively.
- The reduction in the COD achieved using individual treatment of HC under the optimized conditions of inlet pressure as 4 bar and pH as 4 was only 7.9%. The application of different hybrid approaches based on HC such as HC + H2O2, HC + O3, HC + KPS and HC + H2O2 + O3 established higher COD reduction as compared to only HC. The maximum extent of COD reduction as 60.8% was achieved using HC + H2O2 + O3 combination whereas, re- latively lower extent of COD was achieved for operations of HC + H2O2, HC + O3 and HC + KPS with the actual COD reduction being 40.3%, 38.7% and 8.5% respectively.

Sonophotocatalytic Oxidation based treatment of phthalocyanine pigmen containing industrial wastewater intensified using oxidizing agents. (Sudesh D. Ayare, Parag R. Gogate)

In the present study, a novel treatment method based on the combination of ultrasonic and ultraviolet irradiation as well as various additives i.e., oxidants and catalysts has been developed for the treatment of real industrial wastewater containing copper phthalocyanine pigment.

- The effect of operating conditions as ultrasonic power, temperature and pH on the extent of COD reduction has been studied.
- Treatment of phthalocyanine pigment-based effluent using only ultrasound:
- 100ml sample taken in 250 ml glass vessel. operating conditions like ultrasonic power, temperature and pH were varying. pH was varying in the range of 1 to 10, COD reduction was 51.52% at pH 1-2 & the cod reduction is decreased to 22.40% at pH 10.
- Power was varying in the range of 60-110W & 20kHz frequency, The COD reduction typically increased with an increase in the power from 60 to 100 W and a further increase in the power resulted in a decrease in the extent

of COD reduction. 60W: 23.40% ,110W: 51.52%.

- Temperature was varying in the range of 31-44°C. It is observed that COD reduction lowered with an increase in temperature and maximum COD reduction was obtained at 31 °C only with the actual value as 51.52%. The COD reduction at other temperatures of 35, 40 and 44 °C was lower as 43.70%, 41.67% and 25.00% respectively.

The performance study on ultrasonic/Fe3O4/H2O2 For degradation of azo dye and real textile wastewater treatment. (Nematollah jaafarzadeh , Afshin Takdastan)

In this study, the removal of azo dye Reactive Orange 107 (RO107) was investigated by sono Fenton like degradation process using magnetite nanoparticles (MNPs) (Fe3O4). The effective operating parameters (solution pH, H2O2 concentration, MNPs dosage, ultrasonic power and initial dye concentration) were studied on decolorization of RO107.

- Complete removal of azo dye was obtained at 0.8 g/L MPNs, pH = 5, 10 mM H2O2 concentration, 300 W/L ultrasonic power and 25 min reaction time.
- The optimal conditions for complete decolorization of Reactive Orange 107 (RO107) were 0.8 g/L magnetite nanoparticles (MNPs) (Fe_3O_4), pH 5, 10 mM H_2O_2, 300 W ultrasonic power, 24kHz frequency and 25 min reaction time. The COD and TOC removal for real textile wastewater was achieved 79.25% and 66.54% respectively at the same conditions.

Tannery wastewater treatment by cavitation combined with advanced oxidation process. (Sneha Korpe, Bhaskar Bethi)

Studies on degradation of organic pollutants present in waste water released from tannery industry have been carried out in this work. The combined effect of cavitation and magnetic stirring with the advanced oxidation processes has been compared. The different parameters that affect the chemical oxidation process of the tannery waste water, like pH, ultrasound irradiation time and dosage of hydrogen peroxide were studied. The samples were treated by two different approaches by varying these parameters. In the first approach, wastewater was treated in the presence of cavitation using ultrasound probe sonicator and in the second approach in the presence of magnetic stirring using magnetic stirrer was used.

- In both the cases, the suspended total organic carbon (TOC) was measured before and after varying the parameters to ensure the destruction of organic pollutants present in the wastewater sample.
- At 250ml sample taken in 500 ml glass vessel. Power 130W, 22kHz frequency, at 30 °C temperature, pH 2-6, time duration 180min for 2 min on & 1min off, Optimum dose of H2O2 was 2ml/l. TOC reduction 72%.
- The optimum conditions obtained with ultrasonic cavitation was further used in hydrodynamic cavitation set-up in order to increase the efficiency. The experimental results show that the combination of cavitation and H2O2 gives a higher reduction in suspended TOC values of tannery wastewater than with addition of only hydrogen peroxide (H2O2).

Effect of ultrasonic and hydrodynamic cavitation on the treatment of cork wastewater by flocculation and fenton processes. (Zhilin Wu, Francisco J.)

This paper reports that ultrasonic (US) and hydrodynamic cavitation (HC) are efficient strategies for the environmental remediation of cork wastewater (CW).

The pre-treatment of diluted CW using Fenton oxidation (FE) alone led to COD and polyphenol (PP) removal values of 30% and 61%, respectively, while HC and US resulted in 83-90% increases in COD reduction and 26- 33% increases in PP reduction.

- At Power 150W, 25kHz frequency, at 30 °C temperature, pH 10, time duration 30min. 55% COD reduction combined with hydrodynamic cavitation and ultra sound soincation.

Sonochemical techniques to degrade pharmaceutical organic pollutants (N. Tran, P. Drogui, S.K. Brar)

This paper summarizes recent research advances dealing with the development of sonochemical technologies for the degradation of pharmaceutical organic pollutants. The review also includes the mechanism of sonochemical processes, the characteristics of irradiation sources, and the types of reactors used. The important factors affecting the sonochemical oxidation efficiency are discussed, including the electrical power, frequency, and temperature.

- Ultrasound can effectively decompose pharmaceutical com- pounds in aqueous solution, and the extent of degradation depends strongly on the operating conditions, such as ultra- sound power, ultrasound frequency, and temperature of the medium. However, the degradation rate is slow if only the ultrasonic treatment is used. Therefore, some efforts have been made to increase the degradation efficiency by applying hybrid techniques, such as ultra-filtration, biological, UV, Fenton, ozonation, electrochemical, that can increase effectiveness.

Impact of ultrasonic pretreatment on Fenton-based oxidation of olive mill wastewater - towards a sustainable treatment scheme. (Asli S. Ciggin, E. Selinay Sarica, Serdar Dog˘ruel, Derin Orhon)

This study evaluated the potential of ultrasonic enhanced Fenton-based advanced oxidation to reduce toxicity, total phenol (TPh) and organic matter (COD) from olive mill wastewater (OMW).

- 250 ml of sample was placed in a reactor and pretreatment was applied at ultrasound powers 60W/ 60 min and 100W/35 min, 26% and 21% COD reductions could be obtained. 20-30 °C temperature, 20kHz frequency.
- Ultrasound with the Fenton-like oxidation, experimental conditions for 26% COD and 81% TPh reduction were obtained as H_2O_2/COD molar ratio of 1.25 and Fe^{3+} dosage of 3.28 g/L.

3. Conclusion

From the study, it is concluded that the ultrasound sanitation method is used for treatment for different types of waste waters, it can reduce COD, TOC, turbidity. Reduction of COD, TOC, turbidity is dependent on different parameters like temperature,

pH, catalyst dose, power, reaction time. By varying the range of this parameters maximum reduction efficiency can be obtained.

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