Keywords E uent; Ultrasonic waves; Waste water; Media; Bacteria

Introduction

Wastewater is composed largely of the substances responsible for the pathogenic and toxic materials. Processing and disposal of wastewater is one of the most complex environmental problems faced by the engineers as well as scientists in this eld. Today, biological treatment systems are widely used in wastewater treatment due to its high handling capacity and less cost. However, with the increasing population and economic development, most existing biological treatment systems cannot e ciently handle the increasing and complicated wastewater. erefore, numerous wastewater treatment plants have to be reconstructed or extended with high costs and many control techniques to guarantee a constant e uent water quality. When ultrasound is applied to e uent, water undergoes thermal dissociation to H atoms and OH radicals. OH is highly reactive and can oxidise almost all contaminants in water. is primary oxidation is the reason for the degradation of contaminants in water [1-12]. Sono-chemical reactions are normally characterised by the simultaneous occurrence of pyrolysis and radical reactions, especially at high solute concentrations. Volatile solutes undergo direct pyrolysis reactions within the gas phase of the collapsing bubbles or within the hot interfacial (cavity-liquid) region. e bacteriocidal e ect of ultrasonic wave has been evaluated on E. coli ATCC 10536, Salmonella typhimurium ATCC 14028 and Listeria monocytogenesis.

Ultrasound is de ned as acoustic energy or sound waves with frequencies above 20 kHz. Low intensity ultrasound generally refers to that whose intensity is less than 10 w/cm^2. When ultrasound propagates in sound bearing media, it usually can cause some e ects on this media. If the sound bearing media is biological materials, such e ects induced by ultrasound are called biological e ects of ultrasound. When ultrasound propagates in a biological media, rstly it causes mechanical stresses on microorganism, and then part of mechanical energy converses into thermal energy. If the intensity of ultrasound is high enough, the ultrasound can cause cavitation stresses. Consequently, the biological e ects of ultrasound primarily include mechanical e ect, thermal e ect and cavitation e ect.

E ects of Ultrasonic Waves

Vibration e ect

e vibration with high frequency induced by ultrasound causes e ective agitation in liquid media, which increases the uid mixing, di usion and mass transfer of substrate. e boundary layer of stagnant uid adjacent to a solid surface creates a resistance to the transport of small molecules to the surface. e high-frequency vibration reduces the thickness of this boundary layer, thus increasing the convection transport.

Acoustic streaming e ect

When ultrasound propagates in liquid media, it can create the unidirectional and constant sound radiation pressure, which causes the liquid to ow in the direction of the sound propagation. is phenomenon is de ned as acoustic streaming, and it increases with ultrasound intensity. erefore, any amount of ultrasound in a liquid produces additional convection transport from acoustic streaming. Vibration e ect and acoustic streaming e ect both belong to mechanical e ects of ultrasound. ese two e ects can improve the mass transfer and uid mixing through the acceleration of convection transport.

ermal e ect

In the process of ultrasound propagation, the media can absorb the energy of ultrasound and converse it into thermal energy. However, in exposure systems such as enzyme solutions and cell suspensions with e cient heat transfer and narrow temperature control, thermal e ect would make only a marginal contribution to enhanced bio-reaction induced by ultrasound.

Cavitation e ect

Cavitation is a particular phenomenon of ultrasound in liquid media. e molecule of pure liquid has a very high strength of extension. Actually, some minute gas bubbles can enter into the practical liquid for various reasons, which produce the “weak link” of the liquid. e cycles of low and high acoustic pressure causes the gas bubble to expand and shrink, which in turn creates shear ow around the oscillating bubbles. is process of expansion, shrinkage and collapse of gas bubbles induced by ultrasound is called ultrasonic cavitation, and the minute gas bubbles are called cavitation bubbles. Based on the

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di erent behaviour of cavitation bubbles, cavitation can be classi ed as

Ultrasound treatment of waste water

Waste water sample of sewage was collected from Paper and Pulp industry, Meerut (U.P). is is followed by ultrasonic treatment at four di erent duration of time (5,10,20 and 30 min) using ELMA, multi frequency ultrasonic bath (according to manufacture Instruction), e Sonication of wastewater was performed in borosilicate glass vessel (250 ml). During sonication, waste water temperature was increasing gradually with time. pH and electric conductivity of sample were measure by electrode based probe (Water and Soil analysis kit, Electronics India, Model 161E), the rise in temperature of sample on ultrasonic treatment was measure by mercury lled thermometer. In order to characterize this sample pH, electric conductivity, total solid content (gm/l), COD (mg/l), Total Nitrogen, Total Phosphorus, BOD ,Gram staining and Phosphatase activity test were measured.

Screening of isolates for *Phosphatase* activity

e basic principle behind the determination of phosphatase activity is to supply insoluble phosphorus source in agar based medium for the growth of the bacteria. Use of yeast extract is avoided in the medium.Phosphatase activity of all the isolates was tested a er growth in Goldstein solid agar medium which is speci cally used for screening phosphate solubilizers [18].

Coli form test of sewage sample

is technique is mainly use for the detection of presence or absence of coliform bacteria in waste water by ultrasonic treatment. A er 24-48 h. incubation, if colour changes of the medium from redish purple to yellow, indicating the presence of coliform bacteria. But due to the ultrasonic treatment no any population of E. coli was present in the sample. It could be because no any colour changes in the medium. If colour becomes light yellow than it shows positive test.

In the Table 2, all the solutions were made separately and autoclaved. Solutions were cooled down to about 50°C. Solution-2 was added to solution-1 and then solution-3 was added to this mixture. e resulting solution was poured into petri plates and was allowed to solidify. A er a day plates were inoculated with cultures by streaking. Plates were incubated at 30°C for one week. Plates were observed for the zone of solubilisation of insoluble phosphate (Halozone).

Procedure for *E. coli* test by lauryl media

100 ml sample was collected in ask and treated with ultrasonic waves. Sample was transferred into zip lag bag and then in sterile disposable bottle (100 ml capacity). Entire quantity of dehydrated medium (Lauryl tryptose Broth) was added slowly to water sample by swirling to dissolve the powder completely. A er dissolution the sample was incubated at 30-35°C for 24-48 h.

40 KHz and 140 KHz frequency for time 10, 20 and 30 min, respectively including control (without ultrasonic treatment) 5 l of sample was spread on LB plates aseptically and incubated at 32°C for overnight. Bacterial colonies obtained were counted followed by Gram staining, 40 KHz: A, B, C and 140 KHz: A1, B1, C1. It was observed that the number of bacterial colonies decreased with increase of treatment time and frequency (Figures 1, 2 and Table 4).

Phosphatase activity test: With a view to screen Phosphate-sloubilization activity, simple plate test based, on the formation of halo-zone around the colonies were conducted. Out of six isolates, three isolates showed active phosphate-solubilizing character (Figure 3) [18].

Application of ultrasound in biological waste water treatment: Microorganism is the key factor in the biological wastewater treatment, so we can stimulate the activities of microorganisms to improve the treatment e ciency by the application of low intensity ultrasound. According to above analysis of biological e ects and enhancement mechanisms of ultrasound, the proper intensity and irradiation

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10. Ye JZ, Chen CQ, Fang YC, Zhu W, Wang XL (2003) Inetic research on the ultrasonic degradation of organic wastewater and its application. Journal of Hefei University of Technology (Natural Science), 26: 71-76.

11. Dai CY, Wang BC (2003) Effect of low energy ultrasonic on the microorganism fermentation'. Journal of Chongqing University, 26: 15-17.

12. Lin L, Wu J, Ho KP, Qi S (2001) Ultrasound-induced physiological effects and secondary metabolite (saponin) production in Panax ginseng cell cultures. Ultrasound Med Biol 27: 1147-1152.

13. Lin L, Wu J (2002) Enhancement of shikonin production in single- and two-phase suspension cultures of Lithospermum erythrorhizon cells using low-energy ultrasound. Biotechnol Bioeng 78: 81-88.

14. Gronroos J, Mokrini (2005) Sonochemical destruction of waste water. Ultrasound in Environmental Engineering; 28: 250-259.

15. Wu J, Ge X (2004) Oxidative burst, jasmonic acid biosynthesis, and taxol production induced by low-energy ultrasound in Taxus chinensis cell suspension cultures. Biotechnol Bioeng 85: 714-721.

16. Yadav KS, Dadarwal KR (1997) Phosphate solubilization and mobilization through soil microorganisms In: Biotechnological approaches in soil P L F U R R U J D Q L V P I R U V X V W D L Q D E O H F U R S S U R G X F W India. 293-308.

17. Dhermendra K, Tiwari J, Behari, Prasenjit Sen (2008) Application of Nanoparticles in Waste Water Treatment. World Applied Sciences Journal 3: 417-433.

18. Goldstein AH (1986) Bacterial solubilization of mineral phosphates: historical perspective and future prospects, American J. Agriculture, 1: 51-57.

19. Schneider R (1997) Effect of ultrasound on bacterial population in sludge, Ultrasound in Environmental Engineering; 34: 67-74.

20. Flym HG, Atchley (1930) Effect of Ultrasonic cavitation in sludge, Ultrasonic treatment technology, 22: 56-65.