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HYPER SOUND WATER PURIFYING SYSTEM

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INTRODUCTION

All humans daily consume water to sustain life and maintain a good health, therefore water conservation is important and its quality must meet specific standards. The quality of water is determined by many factors such as physical, chemical or biological parameters. The main sources of drinking water are lakes, reservoirs, canal, ground water, sea water, rain water, atmospheric water generation and fog collection that depending on the source of pollutant, their pollution could be different. All water in earth is not good for drinking purpose and must use of some treatment process to achieve the standard quality for therefore we are facing a challenge to produce suitable drinking water. General treatment of drinking water is consisting of several stage to remove or reduction of suspended, dissolved solid and microbial pollutants.

Main process of water treatment include flocculation, sedimentation and media filtration to remove colloidal and suspended solids, ion exchange, carbon adsorption and membrane processes to remove dissolved solids; and at last stage a disinfection for microbial inactivation that often performed by chlorination, ozonation and ultraviolet radiation(UV). Any process of drinking water has some purification limitation and application problems such as high cost, ineffective for removal some pollutant, operation problems and generate toxic secondary pollutants.

One of the innovate technologies that was used for improvement of water treatment process is application of ultrasound (US) waves having a frequency of 20,000 Hz or above that is called "sonication"

Table No. 1 Advantages And Disadvantages Of Conventional Methods

Treatment Method	**Advantages**	**Typical Risks & Problems**
Screening	Removes large suspended particles and consequently partially reduces pollution load. Flow homogenization	Blockage, overflows or odor problems could arise due to infrequent cleaning.
Flow Equalization	Reduced size and cost of downstream treatment facilities	Requires large area in case of high flow rate. Anaerobic condition if not aerated
Settling Basins	Easy to operate Steadiness of treatment operations (Reduced shock loads)	Improper control over sedimentation tanks may cause solids and BOD overloading problems. Fouling Large area requirement
Coalescence	Small & compact Easy operation & maintenance Low cost	Limited capacity Partial removal of emulsified oil
Conventional Activated Sludge	Low land required No problems of flies	High-energy consumption Sludge bulking Requires very highly skilled professionals to operate
Extended Aeration System	Sludge is partially digested within air tank. More resistance to incoming shock load	Retention time in final clarifier twice that of conventional system. Higher consumption of oxygen
Aerated Pounds	Good BOD removal	Higher sludge production High suspended solids in effluent
SBR	Higher efficiency	High power consumption

	Save on area as no separate clarifier is required Less sludge formation	Failure if any problem occurs in the automatic control system
Trickling Filter	Low equipment and power cost Shock loading can be absorbed. Minimum sludge produce	Fly and odor nuisance Limited capacity pounding and clogging of filters
Bio tower	Minimum sludge formation Vertical design, less area required	Fly and odor nuisance Limited capacity Pounding and clogging of filters
Anaerobic Treatment	High organic pollution load Less sludge production	Biogas production Temperature required ($30^{o}C$) Very sensitive to shock load

ULTRASOUND:

Ultrasound is longitudinal wave with a frequency above 20 kHz (Leighton, 1994). This frequency is above the sonic range (20 Hz to 20 kHz) at which humans can hear and below the mega-sonic region (>600 kHz) US could generate by two techniques, firstly "magnetostrictive" electrical energy is converted to mechanical energy (or vibration) with a magnetic coil attached to vibrating piece like nickel and Terfenol-D. Secondly for piezoelectric technique, the electrical energy is converted to high frequency electric energy with piezoelectric crystals (rely to material strain) attached to the vibrating piece (sonotrode, probe or horn). The use of ultrasound technologies has been evaluated for multiple purposes in many systems an against several species of algae, plants, and bacteria. This

FIG.1 Effect on waste water on lake

technology is best suited for small water bodies, including golf course and ornamental ponds, small lakes and reservoirs, lagoons, and marinas. It also has been used to reduce algal biofilms in some water treatment facilities.

1. Ultrasound technology

Introduction

Ultrasound irradiation is a novel advanced oxidation process that has emerged as an answer to the growing need for lower levels of contaminants in wastewater . The basis for the present-day generation of ultrasound was established as far back as 1880 with the discovery of the piezoelectric effect by the Curies . Cavitation phenomenon was first identified and reported in 1895 . Destruction of microorganisms by ultrasonic has been of considerable interest since 1920's when studies of Harvey and Loomis were published. They showed that heating injure the bacteria, but ultrasonic appeared to have a greater effect. Since l945, an increasing understanding of the phenomenon of cavitation has developed coupled with significant developments in electronic circuitry and transducers (i.e. devices which convert electrical to mechanical signals and vice versa). As a result of this there has been a rapid expansion in the application of power ultrasound to chemical processes, a subject that has become known as "Sonochemistry" In the 1960's, research concentrated on understanding the mechanisms of ultrasonic interaction with microbial cells. Cavitations phenomenon and associated shear disruption, localized heating and free radical formation were found to be contributory causes . By 1975 it was shown that brief exposure to ultrasonic lead to thinning of cell walls which was attributed to release cytoplasm membrane from the cell wall. Fecal coliforms inactivation most likely results from a combination of physical and chemical mechanisms which occur during acoustic cavitation, so it is expected that higher intensities will enhance inactivation rates. The correlation of chemical reaction rates and ultrasonic intensity has been reported previously. However, for most processes, increase in process rate not continues with higher sound intensities Since 1990, several studies have focused on the use of ultrasound to remove organic xenobiotics from water.

2. Instruments used sonicator

FIG 2 Typical set up for Sonicator

A Sonicator system is comprised of 3 major components: Generator, Converter and Horn (also known as a probe). The ultrasonic electronic Generator transforms AC line power to high frequency electrical energy. The generator features a keypad or buttons which allow the user to control the sonication parameters. The generator provides high voltage pulses of energy at a frequency of 20 kHz that drives a piezoelectric Converter. The converter is a cylindrical device which is connected to the generator by a high voltage cable. The converter transforms electrical energy to mechanical vibration due to the characteristics of the internal piezoelectric crystals. The vibration is amplified and transmitted down the length of the Probe/Horn. Probes have threaded ends and attach to the converter. During operation, the probe's tip longitudinally expands and contracts. Amplitude is the distance the tip travels and is dependent on the amplitude setting selected by the user.

In liquid, the rapid vibration of the tip causes cavitation, the formation and violent collapse of microscopic bubbles. The collapse of thousands of cavitation bubbles releases tremendous energy in the cavitation field. Objects and surfaces within the cavitation field are "processed." By increasing the amplitude setting, cavitation intensity within the sample is also increased. The probe tip diameter dictates the amount of sample that can be effectively processed. Smaller tip diameters deliver high intensity sonication but the energy is focused within a small, concentrated area. Larger tip diameters can process larger volumes, but offer lower intensity. Boosters can be used to increase the intensity of a larger tip probe to speed up processing times. To ensure a positive outcome, it is important to select the appropriate generator and probe to match the volume, viscosity and other parameters of each particular application. Please consult with a Sonicator product specialist for help making the optimum choices.

3. Sound theory

Most modern ultrasonic devices rely on transducers which are composed of piezoelectric materials. Such materials respond to the application of an electrical potential across opposite faces with a small change in dimensions. This is the inverse of the piezoelectric effect. If the potential is alternated at high frequencies, the crystal converts electrical energy to mechanical vibration (sound) energy. At sufficiently high alternating potential, high frequency sound (ultrasound) will be generated. When more powerful ultrasound at a lower frequency is applied to a system, it is possible to produce chemical changes as a result of acoustically generated cavitation . Frequencies above 18 kHz are usually considered to be ultrasonic. The frequencies used for ultrasonic cleaning, range 20 kHz to over 100 kHz. The most commonly used frequencies for industrial cleaning are those between 20 and 50 kHz Ultrasound has wavelengths between successive compression waves measuring roughly 10 to 10-3 cm. These are not comparable to molecular dimensions Because of this mismatch, the chemical effects of ultrasound cannot result from a direct interaction of sound with molecular species

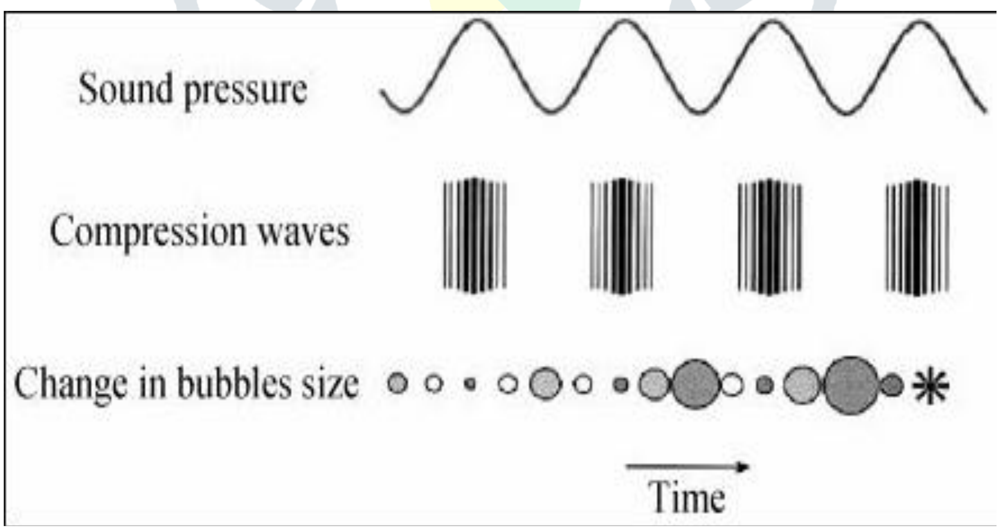

FIG 3 Sound theory

4.Cavitation

Bubble cavitation

Ultrasound reactor technology (USRT) in a liquid leads to the acoustic cavitation phenomenon such as formation, growth, and collapse of bubbles (cavitation), accompanied by generation of local high temperature, pressure, and reactive radical species (°OH , °OOH) via thermal dissociation of water and oxygen. These radicals penetrate into water and oxidize dissolved organic compounds. Hydrogen peroxide (H2O2) is formed as a consequence of °OH and °OOH radical recombination in the outside of the cavitation bubble . ncentration of HO° at a bubble interface can be as high as 4x10-3 M, which is 108-109 times higher than that in the other advanced oxidation processes. Pyrolysis of pollutants could lead to radical formation and starting chain reactions, e.g. degradation of carbon tetrachloride .

The basis for ultrasound irradiation applications is that acoustic cavitation can create a number of mechanical, acoustical, chemical and biological changes in a liquid . Bubbles form, grow and subsequently collapse through compression-rarefaction cycles. Temperature in collapsing bubbles can reach to 3000-5000°K and pressure to 500-10,000 atm. Under such extreme conditions, water molecules undergo homolysis to yield hydroxyl radicals and hydrogen atoms. Since oxidation by hydroxyl radical is an important degradation pathway, amount of the hydroxyl radicals present in the sonolysis system is directly related to the degradation efficiency. There are two main mechanisms in sonolysis system for pollutant decomposition. Pyrolysis reactions in cavitations bubbles Radical reactions by radical species (°H, °OH) from water sonolysis. In elastic media such as air and most solids, there is a continuous transition as a sound wave is transmitted. In non-elastic media such as water and most liquids, there is continuous transi tion as long as the amplitude or loudness of the sound is relatively low. As amplitude is increased the magnitude of the negative pressure in the areas of rarefaction eventually becomes sufficient to cause the liquid to fracture because of the negative pressure, causing a phenomenon known as cavitations. Cavitations bubbles are created at sites of rarefaction as the liquid fractures or tears because of the negative pressure of sound waves in the liquid. As the wave fronts pass, the cavitations bubbles oscillate under influence of positive pressure, eventually growing to an unstable size. Finally the violent collapse of the cavitation bubbles results in implosions, which causes radiation of shock waves from the sites of the collapse. The collapse and implosion of myriad cavitation bubbles throughout an ultrasonically activated liquid result in the effect commonly associated with ultrasound. Thus, sonochemical destruction of pollutants in aqueous phase generally occurs as the results of imploding cavitation bubbles and involves several reaction pathways and zones such as Pyrolysis inside the bubble and/or at the bubble-liquid interface and hydroxyl radical- mediated reactions at the bubble liquid interface and/or in the liquid bulk .

5. Cost Considerations:

Implementation*:* Implementation costs would include purchase and placement of units, and costs related to installation of a power source in the area of treatment. Placement requires no equipment and can be accomplished quickly. The number of units required is dependent on the area of water to be treated. Planning and design activities in this phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures

Operations and Maintenance: In recommended applications, little maintenance is needed. In most applications, the device must be removed from the water for minor cleaning on a monthly basis. Operations would include electricity requirements of approximately 10 watts per hour per unit. Repair and replacement costs would vary, depending on damage from impacts of ice, debris, changing channel depths, and boat traffic. Solar-powered ultrasound units are available, but may have additional maintenance considerations (battery replacement)

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

In this project application of this technology is used for various pollutants removal such as turbidity removal, disinfection or bacteria removal from water and wastewater are studied here by performing various test as Jar test, MPN,DO and BOD determination.

LITERATURE REVIEW

M.R. DOOSTI, R. KARGAR [1] : They have studied this technique could improve the water treatment process environmentally. The various parameters could affect to the efficiency of ultrasound technique such as power density, frequency and irradiation time. So it is needed to obtain the optimum power density, frequency and irradiation time to reach cost-effective. The most experiments are carried out in laboratory scale due to its cost. The utilization of solar energy may help to decrease the cost. It is suggested that the ultrasound technique could be extended to clean up of other polluted parameters in water and the environment.

SHOBHA MUTHUKUMARAN, SANDRA KENTISH [2] : They have studied the ultrasonic cleaning of polysulfide ultrafiltration membranes fouled with dairy whey solutions. The effects of a number of cleaning process parameters have been examined in the presence of ultrasound and results compared with the conventional operation. Experiments were conducted using a small single sheet membrane unit that was immersed totally within an ultrasonic bath. Results show that ultrasonic cleaning improves the cleaning efficiency under all experimental conditions. The ultrasonic effect is more significant in the absence of surfactant, but is less influenced by temperature and transmembrane pressure. Our results suggest that the ultrasonic energy acts primarily by increasing the turbulence within the cleaning solution.

AH MAHVI [3] : They showed that heating injure the bacteria, but ultrasonic appeared.To have a greater effect . Since l945, an increasing understanding of the phenomenon of cavitations has developed coupled with significant developments in electronic circuitry and transducers. As a result of this there has been a rapid expansion in the application of power ultrasound to chemical processes,a subject that has become known as "Sonochemistry" . The basis for the present-day generation of ultrasound was established as far back as 1880 with the discovery of the piezoelectric effect by the Curies Cavitation phenomenon was first identified and reported in 1895. They showed that heating injure the bacteria, but ultrasonic appeared to have a greater effect. Since l945, an increasing understanding of the phenomenon of cavitation has developed coupled with significant developments in electronic circuitry and transducers. In the 1960's, research concentrated on understanding the mechanisms of ultrasonic interaction with microbial cells. Cavitation phenomenon and associated shear disruption, localized heating and free radical formation were found to be contributory causes. Since 1990, several studies have focused the use of ultrasound to remove organic xenobiotics from water .

H. ZHOU AND D.W. SMITH [4] : They have studied that use of conventional water and wastewater treatment processes becomes increasingly challenged with the identification of more and more contaminants, rapid growth of population and industrial activities, and diminish in availability of water resources. Three emerging treatment technologies, including membrane filtration, advanced oxidation processes (AOPs), and UV irradiation, hold great promise to provide alternatives for better protection of public health and the environment and thus are reviewed in this paper. Advantages and disadvantages of these technologies are compared to highlight their current limitations and future research needs. It can be concluded that, along with the growing knowledge and the advances in manufacturing industry, the applications of these technologies will be increased at an unprecedented scale.

K L VODOPYANOV [5] : The aim of the present paper is to demonstrate the feasibility of photo acoustic excitation of ultrasound pulses with high power levels at frequencies of typically 1 GHz and above, representing the frequency limit of commercially available SAMs (2 GHz). Higher acoustic power levels are not only needed to overcome the increasing absorption with rising frequency, but are also useful, if nonlinear acoustic schemes are to be exploited.

PHULL ET AL [6] : (1997) They have studied the use of ultrasound for wastewater treatment and found that ultrasound, in combination with chlorination, was more effective for reducing bacterial colonies over sonication used alone. Ultrasound also reduced the amount of chlorine required for wastewater disinfection (Phull et al. 1997). Ultrasonic technologies coupled with hydraulic flushing effectively controlled blue-green algae blooms in Lake Senba, Japan (Lee et al. 2002).

AKIRA HIRATSUKA, DHUNDI RAJ PATHAK [7] : In this study, ultrasonic waves were irradiated to drinking water for water softening process and other contaminants removal. The experimental results showed that this technique improved the water treatment process efficiently. The study also revealed that the various parameters such as amplitude, frequency and irradiation time could affect the efficiency of ultrasound techniques for the improvement of water quality.

As a research theme of environmental engineering, numerous researchers are much interested in the development of new techniques to get a safe drinking water through purification of water resources . But, development of a novel as well as sustainable and cost effective techniques for the removal of pollutants from drinking water is the challenging issue for environmental professionals. The most widely applied water treatment processes, a combination of some or all of coagulation, flocculation, sedimentation and filtration to reduce or eliminate turbidity and improve water quality. Moreover, ion ex- change, carbon adsorption, membrane processes and dis- infection are generally used to remove contaminants in traditional water purification system. Above processes have some purification limitation and application problems such as high cost, ineffective for removal some pollutant, operation problems and generate toxic secondary pollutants . Such a limitation can be eliminated by the application of innovative techniques such as semiconductor catalysts, forward osmoses, advances oxidation process and magnetic purification.

In this study, an examination for the improvement of water treatment process using ultrasonic waves was carried out. As a result, frequency of ultrasonic waves affecting water quality describing hardness, especially the content of calcium (Ca), sodium (Na), potassium (K) and magnesium (Mg) was confirmed. There will be a possi- bility to make tasty, healthy and immune water if we could have water containing many of the ingredients such as Ca, K and SiO_2. The experimental results confirmed that the ultrasonic waves accelerated the reaction better and improved the water treatment process as well as taste of water significantly. The experimental results also revealed that it is very difficult to compare the efficiency of water treatment process with the effect among irradiation times (30 min., 20 min. and 10 min.) quantitatively which warranting further examination on this.

U. NEIS, T. BLUME [8] : They have studied the Surface waters to be used as resource for drinking water, waste water and sludge produced in treatment processes are very complex media containing soluble, colloidal and particulate matter. Apart from inert or dead matter the colloidal and particulate phase is mainly composed by organic bio-particles (viruses, bacteria, protozoa). Treatment processes like disinfection of potable water, hygienisation of sewage treatment plant effluents or anaerobic sludge stabilisation aim at reducing or inactivating bio-particles. Power ultrasound is used to intensify these processes. Research was conducted to quantify the effects of power ultrasound frequency, intensity and dose. Based on these results the ultrasound reactor design was modified but still has to be optimised.

ANCA STEFAN [9] : They have studied the sonic technology consists in using a installation with an ultrasound generator that induces simultaneously in water during operation an air-jet and ultrasound that influence the physical and chemical characteristics of the water. In order to asses the water quality status, were determined by the basic physico-chemical indicators of treated water, namely the dissolved oxygen, the turbidity, the pH, the content of nitrates, nitrites and ammonia. The paper presents the installation design for sonic treatment of water, the ultrasound generator, the working methodology and the effects of the sonic technology on the water characteristics.

BRITTA WÜNSCH, WOLFGANG HEINE, UWE NEIS [10] : They have studied Bulking and floating sludge cause great problems in many waste water treatment plants with biological nutrient removal. The purification as well as the sludge digestion process can be affected. These problems are due to the interlaced structure of filamentous microorganisms, which have an impact on the sludge's settling behaviour. Foam is able to build up a stable layer, which does not settle in the secondary clarifier. Foam in digestion causes a reduction of the degree of stabilisation and of the biogas production. We use low-frequency ultrasound to combat filamentous organisms in bulking sludge. Low-frequency ultrasound is suitable to create high local shear stresses, which are capable of breaking the filamentous structures of the sludge. After preliminary lab-scale tests now a full-scale new ultrasound equipment is operating at Reinfeld sewage treatment plant, Germany. The objective of this study is to explore the best ultrasound configuration to destroy the filamentous structure of bulking and foaming sludge in a sustainable way. Later this study will also look into the effects of ultrasound treated bulking sludge on the anaerobic digestion process. Up to now results show that the settling behavior of bulking sludge is improved. The minimal ultrasound energy input for destruction of bulking structure was determined.

MUTARANI, Moh. IRSYAD, and AMORANTO TRISNOBUDI [11] ; They have studied ultrasonic waves can give physical, chemical, and biological effect to the medium. One of the effects of the ultrasonic irradiation that will be examined in this research is acoustic agglomeration/flocculation which was proven trough the decrease of water turbidity. The measurement of the decrease was used by turbidimeter. Ultrasonic processing was done by irradiating the ultrasonic waves into liquids with a specific frequency and intensity so that collision between particles occurred due to molecular vibration that inducted from irradiation of ultrasonic waves. This collision will form bigger particles that is easier to be settled.

E. JOYCE, S.S. PHULL, J.P. LORIMER, T.J. MASON [12] : They have studied Some species of bacteria produce colonies and spores which agglomerate in spherical clusters (Bacillus subtilis) and this serves as a protection for the organisms inside against biocidal attack. Flocs of fine particles e.g. clay can entrap bacteria which can also protect them against the biocides. It is because of problems such as these that alternative methods of disinfecting water are under

active investigation. One such method is the use of power ultrasound, either alone or in combination with other methods. Ultrasound is able to inactivate bacteria and deagglomerate bacterial clusters or flocs through a number of physical, mechanical and chemical effects arising from acoustic cavitation. The aim of this study was to investigate the effect of power ultrasound at different powers and frequencies on Bacillus subtilis

A. PETRAUSKAS [13]

In this article of principle construction of water wells and their regeneration methods are discussed. Commonly occurring reasons of water well obstruction are described and presented. The regeneration process of water wells using ultrasound is examined in detail along with the benefits of using this method. The regenerating process of ultrasound is possible because of cavitation effect. The process of cavitation is described and illustrated. Methods of generating ultrasound are presented. Implemented examples of actual regeneration systems are also described and presented along with their technical parameters.

METHODOLOGY

Sonication is adaptable treatment that is to be used for water and wastewater which may be alternative for various conventional treatments from these some application given below:

3.1. APPLICATION OF ULTRASOUND TREATMENT

3.1.1. Application of ultrasound for membrane filtration:

Membrane technologies are now widely accepted as suitable process for separation solids from liquid due to its high removal capacity and ability to meet multiple water quality objectives. Some advantages of this technology are effective in easier to be automated, compact, removing pathogens, requiring less coagulating agents and disinfectors, simpler to maintain and capable of producing high-quality drinking water for human consumption.. In addition to these advantages, membrane filtrations have some operation problems such as concentration polarization and fouling which fouling is more pronounced. Membrane fouling is a process where solute or particles such as natural organic matter, silica, iron oxides, calcite, and clays deposit onto a membrane surface or into membrane pores in a way that degrades the membrane's performance.

These methods have some disadvantages. For example, chemical cleaning of membranes results in increased cost and disposal of waste chemicals and cause secondary pollution. Using US for cleaning membrane have some advantages such as online operation(during the filtration time can be use), without any secondary pollutant and transportation and handling problems, enhancing disinfection of the distribution systems due to present hydrogen peroxide (H2O2) and hydroxyl free radical (OH°) that produced by US. Most ultrasonic cleaning devices work on the principle of cavitation phenomena. Due to this phenomena, acoustic streaming, micro streaming, micro streamers, micro jets, and shock waves could generated that may be capable to preventing the deposition of particles that lead to fouling and dislodge particulate matter from membrane surfaces and enhance the dissolution of substances due to the increased mass transfer of liquid to surfaces.

3.1.2.Application of ultrasound for turbidity:

Turbidity is a principal physical characteristic of water. It is caused by suspended substances or dissolved substances such as clay, silt, finely divided inorganic and organic matter, soluble colored organic compounds, plankton and other microscopic organisms. Conventional methods for reduction turbidity and Total Suspended Solid (TSS) in water treatment process are rapid and slow filtration, microfiltration, ultrafiltration and coagulation/flocculation. In recent years, some studies on application of US for reduction of turbidity and TSS were carried out. An experiment with variation of time, power, and variation of frequency of US irradiation was performed. Time period using 0.5, 1, 1.5, 2 and 2.5 hours and four conditions of frequency and power 20 kHz 25 W, 28 kHz 30 W, 45 kHz 40 W, and 200 kHz 100 W were applied.

3.1.3.Application of ultrasound for algae removal:

Algae growth is the common problem in the water treatment plants and water reservoir. Algae are aquatic organisms classified separately from plants. Algae are a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms, such as the giant kelps that grow to 65 meters in length. A novel technique for control algae growth is ultrasonic irradiation. US can destroying the algae by initially physical pathways that the main destroying performed by cavitation phenomena. Control mechanisms that was reported may be consist of: production of free radicals, disruption of gas vesicles and inhibition of photosynthesis.

Although increase of some types of algae was reported that 67% increase of Microcystis sp during continuous application of US at a frequency of 28 kHz an power 20 W and 60% increase of Spirulina platensis after a pulse of 12 minutes every 11 days of 1.7 MHz US frequency was reported.

3.1.4.Application of ultrasound for water disinfection process:

The water disinfection process is fundamental to remove microorganisms and can be done by different methods such as use of Ultraviolet and chemical substances, like are chlorine, hypochlorite, chloramines, chlorine dioxide, bromine and ozone Their effectiveness can be considered respectively: ozone chlorine bromine chlorine dioxide hypochlorite chloramines. US technique in many studies has investigated in different condition such as alone disinfection process, as pretreatment or combined by other disinfection methods such as UV, chlorine, Ozone for water disinfection. Hulsmans and colleague have evaluated the effects of process parameters ultrasonic water disinfection system.

3.1.5.Application of ultrasound for water softening process:

Water hardness is known as existence of bivalent and trivalent cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), and in lower traces; aluminum (Al^{2+}, Al^{3+}) and iron (Fe^{2+}, Fe^{3+}) that among these cations, Ca^{2+} and Mg^{2+} are the main factors of hardness.Water hardness cause some problems such as scale formation in pipes and cooling tower, reaction by soap and formation hard foam and decrease heat change capacity and membrane clogging.. Conventional methods for hardness removal are lime-soda process, ion exchange, electrocoagulation, electrodialysis and nano-filteration. Entezari and Tahmasbi used combined US irradiation operating at 20 kHz and ion exchange process for hardness removal from water. They used styrene-divinylbenzene co-polymer with sulfonic acid group as a strong acid cation resin. Effect of different parameter such as contact time, amount of sorbent, temperature and ion concentration were investigated.

3.2.LABORATORY PROCEDURE FOR WORK AT VARIOUS PARAMETERS FOR WATER AND WASTE WATER:

3.2.1.TURBIDITY:

APPARATUS :Turbidity meter ,flocculator,beakers etc

REAGENTS : 1. 1% Alum solutions

2. 1% Lime solutions

3. Turbide water sample

PROCEDURE:

A) Calibration of Nephalometer:

1. Prepare the standered turbid solution of known concentration

2.Select the appropriate filter for test

3.Take distilled water in test tube and put this test tube in to the hole

4.Adjust the knob so that 100% transmission is possible

5.Take out the test tube replace the distilled water with standerd turbide solution

6.Put on the ligt switch and note down the % transmission reading.

7.Takeout the test tube fill it with given sample of turbid water and insert it into hole

8. Put on the ligt switch and note down the % transmission reading

B) To determine optimum dose of alum

1.Take 500ml of raw water of known turbidity in each jar

2.To each jar add varying dosage of alum and lime solution selected from the following table.

Table No.2 Alum and lime dosages REF: laboratory manual.

	Alum solution 1%	**Lime solution 1%**
5 mg/lit	0.25 ml	0.1 ml
10mg/lit	0.50 ml	0.2 ml
15mg/lit	0.75 ml	0.3 ml
20mg/lit	1.00 ml	0.3 ml
25mg/lit	1.25 ml	0.4 ml
30mg/lit	1.50 ml	0.5 ml

3.The selected dosages of alum should include the optimum dosages reuired for particular turbidity of sample

4.Lime dosages just neutralize acidity included by alum process if ph of raw water sample is less than 7 ph correction is necessary

5.Flash mixes the contents of each jar for 30sec.

6.Keep jar in the flocculator and flocculate for 20 min.

7.Stop flocculation and allow the flocculated particles to settled for 20 to30 minutes

8.Draw the supernatant from each jar determine its turbidity and report the optimum dosages

TURBIDITY BY USING SONICATOR

1. Collect the fresh raw wastewater sample.
2. By using Sonicator allow to pass ultrasound wave for different time.
3. Allow it particle to steeled for 30 min.
4. Then measure turbidity by using Nephalometer .

3.2.2. MPN :

APPARATUS: Fermentation Tubes, Durham tubes,Autoclave,incubator.

PROCEDURE:

1. Sterilize fermentation tubes & durhams tubes at 100°c fo 30 min.in autoclave

2. Prepare 3 sets of three fermentation tubes.
3. Pipette out 10ml,1ml,0.1ml of given sample in first second & third set respectively in each three tubes.
4. Add 10 ml lactose broth in each tube.
5. Fill Durhams tubes with resulting solution from each tube.Insert all the Durhams tubes in inverted position in each tube.And close the mouth of fermentation tubes with cotton plug.
6. Place all set in incubator for 24hrs at 35°c .
7. After incubation period is over each tube is carefully examined for gas formation. Confirmation of gas formation is done by observing bubbles formation in the Durham's tubes. Even a tiny bubble is recorded as a positive gas formation.
8. Count the number of Durham's tubes showing positive gas formation from each set.
9. Follow the table given below which shows no.of tubes giving positive out of 3 from each set & corresponding MPN index.

Ref: Laboratory manual.

Table No.3 MPN index

3 of 10 ml each	3 of 1ml each	3 of 0.1ml each	MPN index per 100mm
0	0	1	3
0	1	0	3
1	0	0	4
1	0	1	7
1	1	0	7
1	1	1	11
1	2	0	11
2	0	0	9
2	0	1	14
2	1	0	15
2	1	1	20
2	2	0	21
2	2	1	26
3	0	0	23
3	0	1	39
3	1	2	64
3	1	0	43
3	1	1	75
3	1	2	120

3	2	0	93
3	2	1	150
3	2	2	210
3	3	0	240
3	3	1	460
3	3	2	1100
0	0	0	<2

DISINFECTION BY USING SONICATOR

1. Collect the fresh raw wastewater sample.

2. Allow to passing ultrasound wave for 45 min.

3. Then by using same MPN method find most probable number of treated waste water sample.

3.2.3. D.O DISSOLVED OXYGEN:

REAGENTS

1. Manganous Sulphate.
2. Alkali-Iodide Azide Solution
3. Concentrated sulphuric Acid
4. Strach Indicator
5. Sodium Thiosulphate (0.025N) Na2S203
6. Potassium Dichromate Solution.(0.02)

THEORY

Solubility of atomospheric oxygen in water depends on altitude,temp. & salt concentration in water At O°c,20°c & 35°c saturation.D.O concentration is 14.62,9.17 & 7.0 mg/lit respective in clean water at 1.0 atmospheric pressure.

Higher temp.higher salt concentration higher altitude & higher organic matter content reduce the dissolved oxygen in water.

PROCEDURE

1. Fill the BOD bottle (300ml) without any turbulence & stopper the bottle.
2. Remove the stopper & first add 2ml of MnSO4 & 2ml 0f alkali-iodide-Azide using a pipette below liq. Level in BOD bottle. Stopper the bottle.
3. Formation of White precipitate indicates, absence of DO. If DO is present there will be brown precipitate.
4. Remove the stopper & add 2ml of concentrated H2SO4 (36N) below liquid level in B.O.D.bottle.stopper the bottle & shake the bottle until the brown precipitate completely dissolves to

give a uniformly yellow coloured solution.yellow colour is due to formation of free iodine from oxidation of iodide.

5. Take 203ml solution from 300ml BOD bottle.Extra 3ml is the correction for 4ml of added reagents.
6. Titrate it with sodium thoisulphate using starch indicator until blue colour changes to colourless.

BY USING SONICATOR FIND D.O

1. Collect the fresh raw wastewater sample.
2. Allow to passing ultrasound wave for 45 min.
3. By using above method find D.O

3.2.4. B.O.D.(BIOCHEMICAL OXYGEN DEMAND)

REAGENTS:

1. Distilled water
2. Phosphate Buffer Solution
3. Magnesium sulphate solution
4. Alkali-Iodide-Azide solution
5. Calcium chloride solution
6. Manganese sulphate solution
7. Ferric chloride solution
8. Standard Sodium Thiosulphate solution
9. Starch indicator
10. Concentrated Sulphuric Acid.

THEORY

BOD is defined as the amount of D.O req.by bacteria to oxidize the decomposable organic matter present in wastewater under aerobic condition.A known volume of sample of wastewater under aerobic condition. A known volume of sample of waste water in incubated at 20degree/c for 5 days. D.O depletion in the test bottles is a measure of amount of biodegradable organic matter present in the sample.

PROCEDURE

A).Preparation of dilution water

1. Aeriate 1liter distilled water to get D.O.above 7mg/lit.

2.Add 1ml each of phosphate buffer , magnesium sulphate,calcium chloride, ferric chloride.

3. Add 2ml settled sludge(for seeding).

B).BOD TEST

1. Fill two bottles with samples diluted with dilution water.

2. Keep 1 bottel for incubation and final initial D.O. of another bottle.

3. Fill two bottles with dilution water.
4. Keep 1 bottel for incubation and final initial D.O. of another bottle.
5. Find D.O of incubated bottles after 5 days incubation.

BY USING SONICATOR FIND OUT B.O.D REQUIRED

1. Collect the fresh raw wastewater sample.
2. Allow to passing ultrasound wave for 45 min.
3. By using above method find out B.O.D

DETAILED SPECIFICATION OF SONICATOR USED :

Name of supplier	:	Sidilu ultrasonics,Banglore
Frequency of sonicator	:	20 khz
Time of running in 1 cycle	:	3 minute.

FIG. 4 Bath Tube Type Sonicator

RESULTS

After determination of various parameters and test , catch the following results

4.1.TURBIDITY

By Using Flocculation/Jar Test Method

Initial turbidity: 85 NTU

Table No: 4 tubidity by jar method

SAMPLE	1%alum solution	1%lime Solution	TURBIDITY
5mg/lit	0.25ml	0.1ml	27 NTU
10mg/lit	0.50ml	0.2ml	25 NTU
15mg/lit	0.75ml	0.3ml	24 NTU
20mg/lit	1.00ml	0.3ml	21 NTU
25mg/lit	1.25ml	0.4ml	19 NTU
30mg/lit	1.50ml	0.5ml	20 NTU

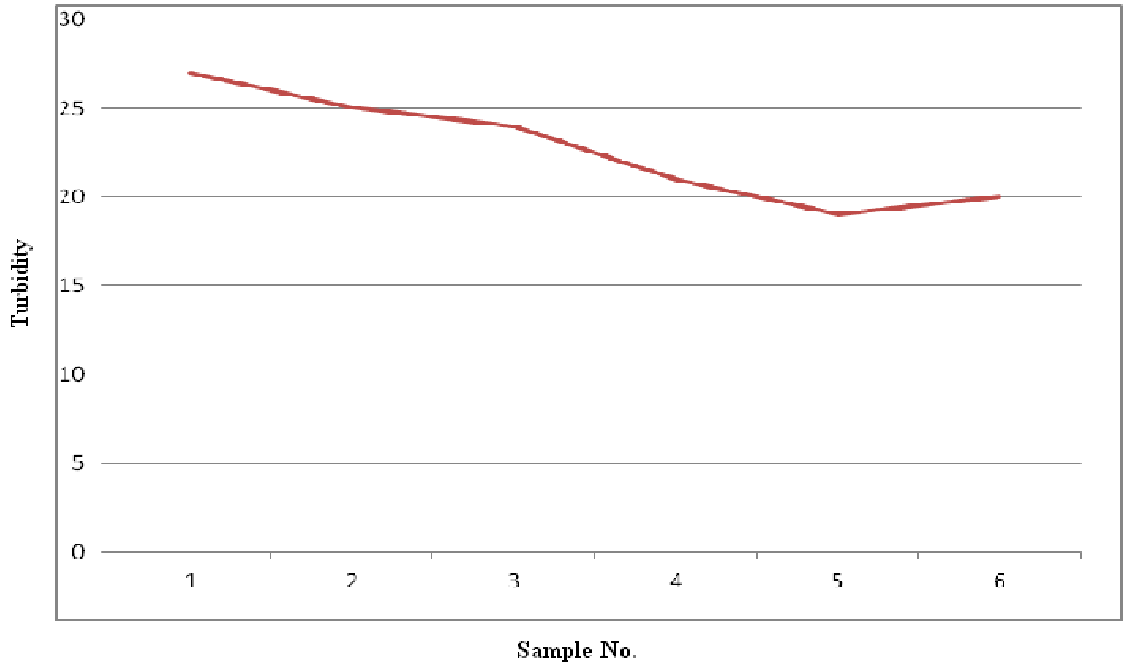

FIG. 5 Showing Turbidity removal in Jar test

BY USING SONICATOR

Initial turbidity :85 NTU

Table No. 5 Showing Turbidity removal by using sonicator

Time	Frequency	Turbidity
15min	20khz	37
30min	20khz	35
45min	20khz	31
60min	20khz	30

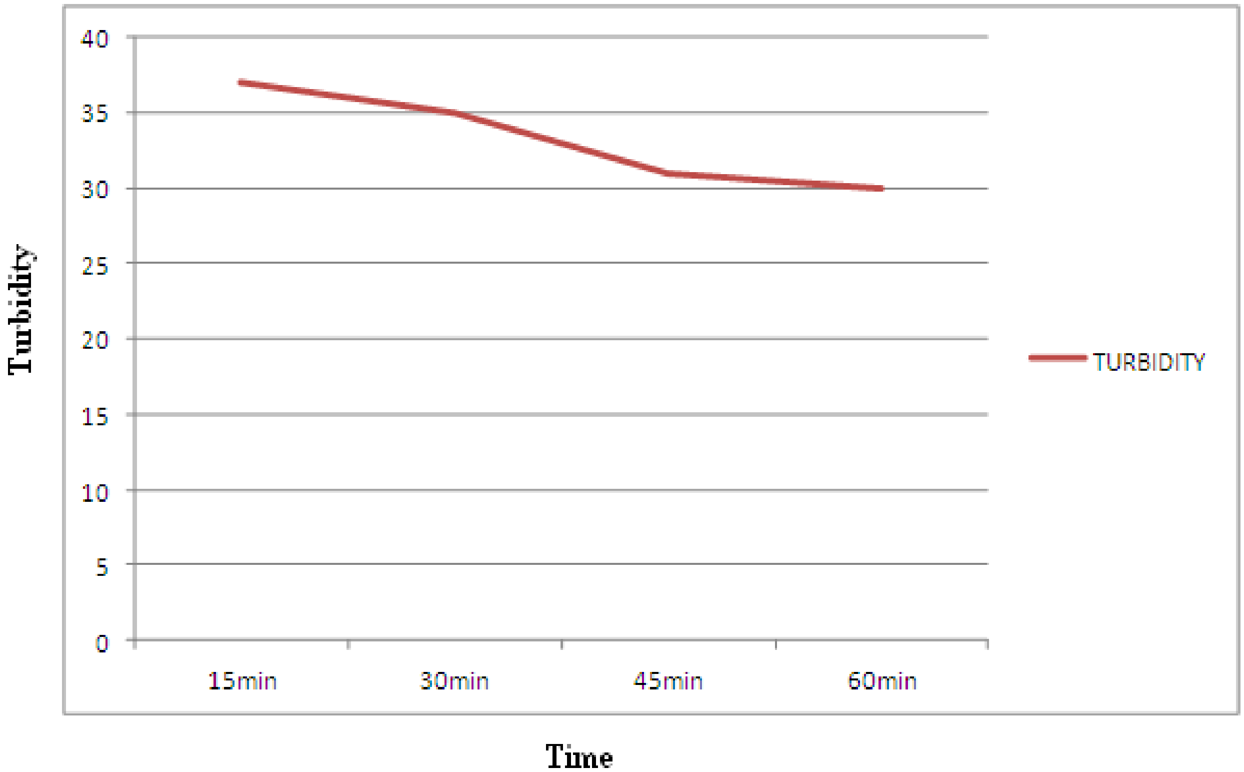

FIG. 6 Shows turbidity removal by using sonicator

By conventional treatment the minimum turbidity is 19 NTU

By Sonicator minimum turbidity is 30 NTU at 60min.about 20khz frequency.

4.2.DISINFECTION : MPN INDEX.

Readings before sonications:

Table No. 6 showing MPN results before sonication

3 of 10 ml each	3 of 1ml each	3 of 0.1ml each	MPN index per 100mm
1	0	1	7

Readings after sonications:

Table No. 7 shows MPN results after sonication

3 of 10 ml each	3 of 1ml each	3 of 0.1ml each	MPN index per 100mm
0	0	0	<2

By using MPN before sonication we find out 7 most probable number.after by using sonicator and found mpn value near to zero

Therefore we can say the sonicator can disinfect waste water up zero disinfection.

4.3.DISSOLVED OXYGEN DETERMINATION

D.O. water before sonication treatment :

Dissolved oxygen is increases by using 20khz with time 45minute running .

Calculation of Dissolved Oxygen Before Treatment

Calculation of D.O.=

1. Normality Na2So3= $\frac{0.025 \times 10}{ml\ of\ titrant}$

$= \frac{0.025 \times 10}{19.6}$

$= 0.0127$

For 1st day

2. D.O For Distilled Water (B1) $= \frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{8.5 \times 0.0127 \times 8 \times 1000}{203}$

= 4.25 mg/lit

3. D.O. For w/w (D1) = $\frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{4.7 \times 0.0127 \times 8 \times 1000}{203}$

= 2.35 mg/lit

After 5 days

4. D.O for Distilled Water (B2) $= \frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{10.6 \times 0.0127 \times 8 \times 1000}{203}$

=5.30 mg/lit

5. D.O.w/w sample (D2) $= \frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{2.09 \times 0.0127 \times 8 \times 1000}{203}$

= 1.05 mg/lit

1^{st} day

For distilled water: 4.25 mg/lit

For waste water : 2.35 mg/lit

At 5^{th} day

For distilled water: 5.30 mg/lit

For waste water : 1.05 mg/lit

D.O of water after sonication treatment

At 1^{st} days:

1. D.O For Distilled Water (B1) $= \frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{12.7 \times 0.0127 \times 8 \times 1000}{203}$

= 6.36mg/lit

2. D.O. For w/w (D1) = $\frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{13 \times 0.0127 \times 8 \times 1000}{203}$

= 6.50mg/lit

After 5 days:

3. D.O for Distilled Water (B2) $= \frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{9 \times 0.0127 \times 8 \times 1000}{203}$

= 4.50mg/lit

4. D.O.w/w sample (D2) $= \frac{A \times N \times 8 \times 1000}{ml\ of\ sample}$

$= \frac{16.5 \times 0.0127 \times 8 \times 1000}{203}$

= 8.26mg/lit

1^{st} day

For distilled water: 6.36 mg/lit

For waste water : 6.50 mg/lit

At 5^{th} day

For distilled water: 4.50 mg/lit

For waste water : 8.26 mg/lit

From obtained results we found that dissolved oxygen is increased by using Sonicator is about 6.36 mg/lit for 1st day result.

From obtained results we found that dissolved oxygen is increased by using Sonicator is about 8.26 mg/lit for 1st day result.

4.4. BOD DETERMINATION:

BOD calculation:

1. Normality of Na2So3 = $\frac{0.025\times10}{ml\ of\ titrant}$

$$= \frac{0.025\times10}{19.6}$$

$$= 0.0127$$

For wastewater

$$BOD5 = \frac{(D1-D2)-(B1-B2)\times F\times1000}{ml\ of\ sample}$$

$$= \frac{(2.35-1.05)-(4.25-5.30)\times2\times1000}{203}$$

= 10.35 mg/lit

For Sonicator:

$$BOD5= \frac{(D1-D2)-(B1-B2)\times F\times1000}{ml\ of\ sample}$$

= NIL.

BOD determination before sonication : 10.35 mg/lit

BOD determination after sonication : Nil.

Biological oxygen demand is more for waste water before using sonicator but after using it we found that the biological oxygen demand for waste water is nil.

CONCLUSION

After studying various test and references we can say that the ultrasound wave techniques are used for wastewater treatment plant.

- By using ultrasound wave method we can removing turbidity maximum without using flocculation process. From this we can replace the flocculation tank from the wastewater treatment plant. also minimize the chemical cost required for it .

- By using ultrasound wave method we got result total disinfection, zero infected virus @ 20khz within 45 minutes. So from this we can minimize the chemical cost required for disinfection and also we can replace the chlorination process from wastewater treatment plant

- After using the ultrasound wave method "DO" of waste water increases, so no necessity to mixing the oxygen by using another method .

- So by the replacing flocculation tank, sedimentation tank, chlorination tank we can only used the ultrasound wave method in waste water treatment plant .

- So the construction cost and the running cost we can minimize.

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