

DESALINATION OF SEA WATER THROUGH NATURAL METHOD AND REDUCTION OF TDS USING MICRO NANO BUBBLE TECHNOLOGY

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering Degree in

Mechanical Engineering

by

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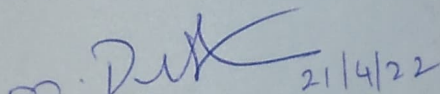
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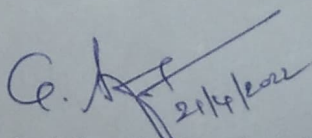
This is to certify that this Project Report is the bonafide work of **Kusam Vamsi Reddy(38150057)** and **R.Hemanth Sai Kiran (3815004)** who carried out the project entitled **"DESALINATION OF SEA WATER THROUGH NATURAL METHOD AND REDUCTION OF TDS USING MICRO NANO BUBBLE TECHNOLOGY**

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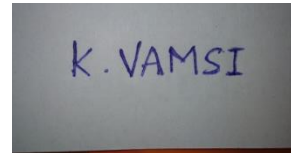
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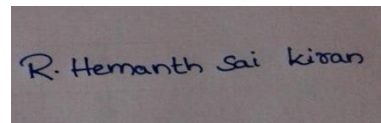
We, **Kusam Vamsi Reddy (38150057)** and **Rudhrakshula Hemanth sai kiran (38150094)** here by declare that the Project Report entitled “**DESALINATION OF SEA WATER THROUGH NATURAL METHOD AND REDUCTION OF TDS USING MICRO NANO BUBBLE TECHNOLOGY**”, done by me under the guidance of **Dr.M.Purusothaman,M.E.Ph.D. at SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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ABSTRACT

Desalination of sea water through natural method and reduction of TDS using micro nanobubble technology is the focus of this report. Some of the benefits of high oxidation capacity, high mass transfer efficiency, high utilisation rate of reagents, and simple method for treating pollutants (MNBT) have drawn attention and been effectively utilised. Water treatment technologies are becoming more popular as a solution to global environmental problems including pollution and scarcity of freshwater resources.

When it comes to wastewater treatment, micro and nanobubble technology has arisen as an alternate solution. MNB-based water treatments are also being employed in a wide range of industries, including agriculture and industry, due to its enormous practicality. The current state of MNB research, as well as potential trends in MNB utilisation, will be discussed. As of late, research on MNBs for water-related applications has expanded altogether, with the goal of determining their viability as a long-term water treatment technology. This document summarizes the studie and results on seawater treatment in the field of MNBs and examines the natural method on the reduction of TDS and salinity. The TDS and salinity of the original sea water sample are 41920mg/l and 33.84 %, respectively. For cavitation one hour process we got TDS value is 36440mg/land 32.2%. and after cavitation process we have added the thethankotai powder for 24 hours the TDS 34478mg/l, then 31491mg/l for 48 hours, and finally 31491mg/l for 72 hours TDS is 30638mg/l. here TDS value is reduced with respect to its salinity also reduced.

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LIST OF ABBREVIATIONS

ACRONYM		ABBREVIATION
MNB's	-	Micro Nano Bubbles
DO	-	Dissolved Oxygen
TDS	-	Total Dissolved Solids
TSS	-	Total Suspended Solids
BDL	-	Below Deduction Limit

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CHAPTER – 1

INTRODUCTION

World economic development is inseparable from this water supply. Today, water resources in many developing countries face severe problems including water shortages, water distribution imbalances, and production model insufficiencies, inefficient water use, drought and other environmental problems. As a result of rising urbanisation and industrialization, the volume of wastewater is increasing, which considerably raises the issues of both water supply and quality. As a result, the need for wastewater treatment and recycling is growing in importance in order to maintain adequate water supplies. Activated sludge, for example, has been used for decades to remove pollutants from both industrial and residential wastewater. However, such processes have drawbacks, including as high energy costs and the production of a large volume of solid waste, which adds to the expense of disposal. There is a convincing need to foster a water treatment framework that can actually and economically handle the rising issues of water lack.

Micro- and nanobubbles (MNBs) have emerged as a viable solution for water treatment in such a circumstance. Nanobubbles are spherical shape packets having a diameter of less than 1 μm that can also be found at the boundary between solid and liquid, or across a liquid media. As opposed to customary microbubbles (measurement under 50 μm) or enormous air pockets (distance across more than 1 mm), mass nanobubbles have interesting actual elements that stand out in bioremediation, horticulture and biomedicine, with technological advantages and prospects in wastewater treatment.

Electro flotation and dissolved air flotation are two common water treatment techniques that contain MNBs. Because MNBs have a greater bioactivity, they have been commonly implemented in recent years for the detoxification of water treatment in home and commercial settings. The high viability of MNB-based water treatments has led to their application across a wide range of sectors, including manufacturing and agriculture. Because of their enormous surface area, they facilitate chemical reactions by allowing for rapid mass transfer between the

liquid and gas phases. The collapse of the MNB causes shock waves in the water and the formation of OH radicals as a consequence of these activities.

MNB research for water-related applications has exploded in recent years, with the objective of confirming their long-term durability as a water treatment approach. MNBs' usage and use in water treatment is currently restricted, despite a significant body of research and experimental data. For the purposes of this study, a review of published research on micro–nanobubbles and wastewater treatment uses is being provided to the reader.

1.1 FUNDAMENTAL PROPERTIES OF MNBS

The three types of water bubbles seen in nature are ordinary macrobubbles, microbubbles (MBs), and nanobubbles (NBs). Bubbles with a diameter of more than a millimetre are known as macrobubbles. They rise quickly to the liquid's surface before dissipating into the surrounding fluid. This is a smaller kind of bubble than macrobubbles, with a diameter of one metre or more to one hundred metres, and they dissolve in water before they can grow again. As opposed to typical gas bubbles, NBs are microscopic gas bubbles that exhibit a variety of unique physical characteristics as shown in fig 1.5. NBs usually have a diameter of $<1\ \mu\text{m}$; However, NBs with a diameter of less than 100 nm drift randomly in so-called Brownian motion and have low buoyancy. It can be left suspended in liquid for a long time and has the capacity to change the commonplace properties of time and water as shown in fig1.1. Despite later research, there is still debate on the size of NBs and whether they exist in solutions under atmospheric circumstances. Because of the radius curvature limit, NBs cannot exist or be stable, according to classical thermodynamics theory. Because of the small radius of curvature, NBs have better internal pressure than external pressure, resulting in a faster dissolution rate. The key assumption behind these phenomena is that the NB's high internal pressure does not attain stability with the atmosphere, causing the bubbles to burst in a short period of time. To their knowledge, Lou et al. were quick to consider NBs to be splendid and actually stable circles on a level strong surface on account of AFM estimations (nuclear power microscopy).

In any case, ongoing years have seen the reception of new techniques for NB examination, including as neutron reflectometry, X-beam reflectivity, and quartz

precious stone microbalance. The extended lifespan of NBs allows them to have a wider contact angle and spend more time in liquids, which is one of their distinguishing characteristics.

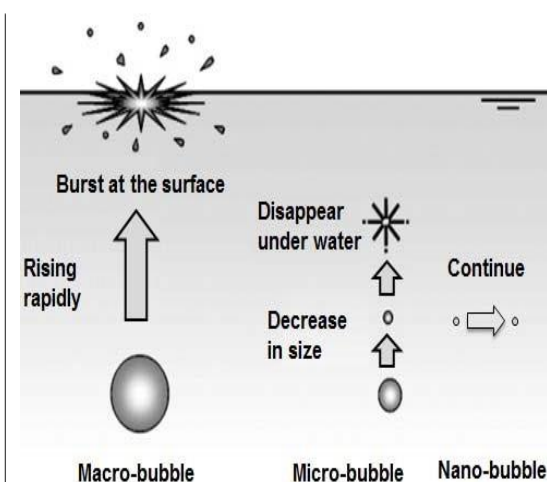
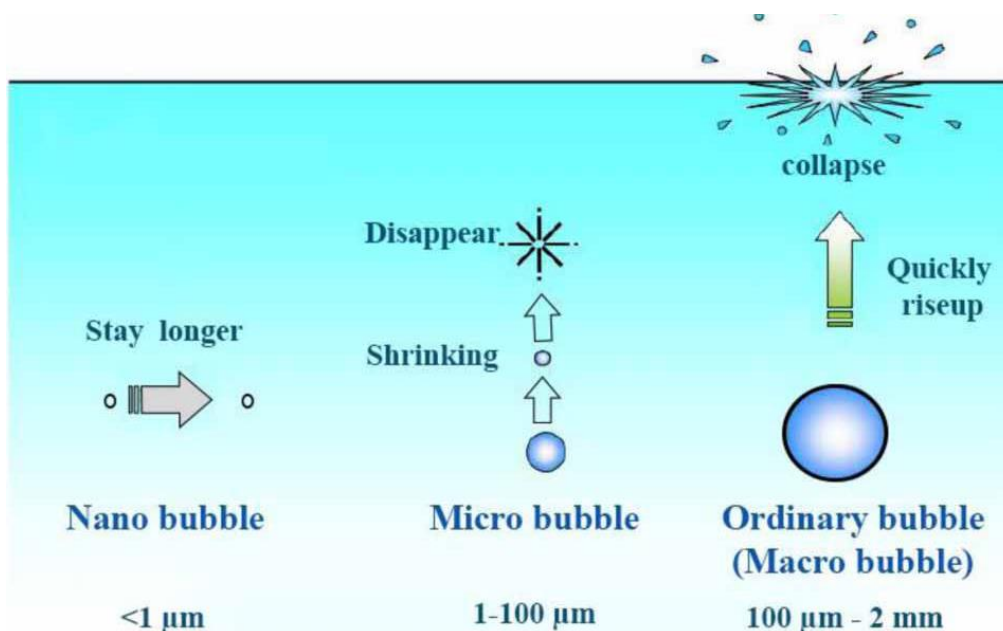


Fig 1.1. Behavior of Macrobubble, microbubble (MB) and nanobubble

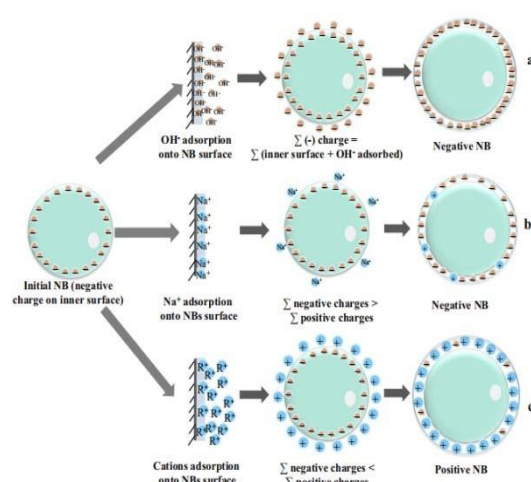


Fig 1.2. Mechanism of negatively and positively charged MNBs generation

1.1.1 High stability

Johnson and Cook published their first paper on studying large nanobubbles (1981). They found that shearing seawater could produce nanometer-scale gas-filled bubbles that were stable for up to 24 hours due to the presence of surface films produced by naturally occurring surfactants. The additional pressure

exerted on the spherical bubbles in the liquid can be explained using the Young-Laplace equation by classical thermodynamics.

$$p_c = \sigma (1/R_1 + 1/R_2),$$

for above equation p_c =capillary pressure, and the pressure difference at the interface between the two liquids with respect to the surface tension σ and R_1, R_2 =principal curvatures.

However, in the past ten years, the development of nanobubble following innovation, for example, laser diffraction procedures and other discovery strategies has demonstrated that nanobubbles may live in fluid media for an extensive timeframe. Their compact size and great interface potential are to blame for this. Ordinary huge bubbles will quickly rise to the surface due to buoyancy and dissipate, however bulk nanobubbles might float for days or even months.

1.1.2 Zeta potential of MNBs

Measurement of the amount of the attraction or electrostatic repulsive force between a particle and bubble is done using zeta potential. The life span of colloidal MNBs is largely determined by this feature. The zeta potential is determined using the Smulochowski equation. MB and NB have a zeta potential of 50-40 mV and 30-20 mV at neutral pH, respectively, depending on the kind of gas being supplied. An interface between gas and water has an excess amount of hydroxyl (OH) and hydrogen (H) ions, and this imbalance is what defines the negative value of the zeta potential. Hydroxyl ions preferentially adsorb in the electrolytic solution, which is connected to the charging process of NBs. Furthermore, the NBs' stability is heavily dependent on hydrogen bonding at the water–gas interface, leading in an impermeable, kinetically stable, and diffusion-resistant surface.

1.1.3 Mass transfer properties

A process's efficiency in different gas-liquid phases is typically defined by the rate at which gas and liquid are transferred. Because of this, mass transfer is an essential system characteristic. Bubble size distribution, ascent rate, gas-liquid hydrodynamics, decay coalescence, surface-area-to-volume ratio, and physical qualities are all factors that affect the efficiency of mass transfer. Two-membrane gas absorption theory states that mass transfer between two not entirely set in stone by the mass exchange coefficient of fluid gas and the surface region. angles in

volume and fixation between stages The gas-liquid mass transfer coefficient is determined using the unsteady state approach. Studies show different correlation approaches for calculating mass

Various mathematically based MB transfer coefficients model. Bredwell& Worden proposed a dynamic approach that focused on factors such as mass transfer coefficient reductions in bubble size. A single MB of 25 μm was used to solve this numerically. Additional research has been done by Ying et al. The mass transfer coefficient may also be improved by using a model created by our team. Depending on the size of the bubbles, the pace at which carbon dioxide is transferred is affected. As for the next step, Li et al. created a stirring reactor. It was used to investigate mass transfer mechanisms in the nanometer range. According to their findings, even modest amounts of bulk liquid heated by the MB generator have an impact on gas solubility and temperature. They used the temperature correlation coefficient at 20 °C to compute the mass transfer coefficient.

1.1.4 High gas-liquid mass transfer

Bulk nanobubbles rise to the surface of water due to the presence of a gas-liquid interface that compresses the bubbles, resulting in continual shrinkage and self-pressurization of the nanobubbles as they rise to the top. Expansion in mass exchange from the air pocket to the fluid and decrease in gas dispersion from the high-pressure zone to the low-pressure region are both connected with pressure slopes (change of tension per unit distance). Mass nanobubbles have a critical specific surface region since bubble surface region is contrarily connected with span.

As a result of the mass nanobubbles' self-compression activity, long home times, and colossal surface regions, more gas might break up into water across the air pocket interface, significantly further developing gas move effectiveness to the fluid stage. Bubbles will collapse and eventually dissipate unless their internal pressure exceeds a specified limit value.

Strong ultrasound and hydrodynamic cavitation have been proven in several investigations to produce the breakdown of nanobubbles and the age of free extremists. During the contracting of nanobubbles, the electric charge thickness in the electric twofold layer develops quickly. Whenever an air pocket explodes, a huge grouping of particles structures on the gas-fluid point of interaction, releasing

chemical energy that had been trapped within. This results in the formation of a variety of reactive oxygen species (ROSs), such as superoxide anion radicals (O_2^-) and singlet oxygen (1O_2), when water molecules are squeezed by dynamic stimuli and subjected to very high temperature and pressure. To address persevering natural contaminations in wastewater treatment and microbe sanitization, these receptive oxygen species' solid oxidation movement is being investigated for use in cutting edge oxidation procedures.

Bulk nanobubbles are attracting increased interest in the wastewater treatment area due to the unique benefits outlined above, and they show remarkable potential in improving standard organic matter removal techniques. Bulk nanobubbles have been shown in previous studies to have the ability to remove pollutants from water by a variety of means, including: (1) further developing the air buoyancy process for the expulsion of lipids and oils; (2) advancing air circulation in water to reinforce the conventional biodegradation cycles of organically actuated carbon channels, enacted ooze and film bioreactor ; and (3) Generates bulk nanobubbles.

1.2 MNB GENERATION MECHANISM

MNB is formed on the surface of hydrophobic particles. Depending on the inside or outside MNB formation can be triggered by several factors. Typically, blisters are formed by heating the gas under pressure and then releasing the gas while decreasing the pressure bubbles. A water pump, an air compressor, and an air tank are the key components of this equipment in this operation. Water is pumped into the dissolved gas tank and air at a predetermined pressure by the water pump. In a high-pressure gas-water mixed condition, the compressor forces air into the dissolved gas tank, where it forms MNB owing to abrupt decompression and precipitates the gas. The pump in the transparent acrylic tank pumps the water through the gas dissolution tank and the MNB production nozzle. Suction side of the pump injects air, and a high-pressure system releases it back into the water. Due to the pressure drop at the nozzle, MNB gas is created from water that has been oversaturated with air [15]. There are many variations on how MNBs are generated, comparing different bubble generation principles. When abrupt pressure changes cause a phase transition in a uniform liquid phase, NB often happens.

A key value known as cavitation has been met. Cavitation is usually caused by high pressure changes in the passage of ultrasonic waves or flowing liquids (hydrodynamic cavitation). Ultrasonication and chemical reactions such as electrolysis can also produce MNB'S.

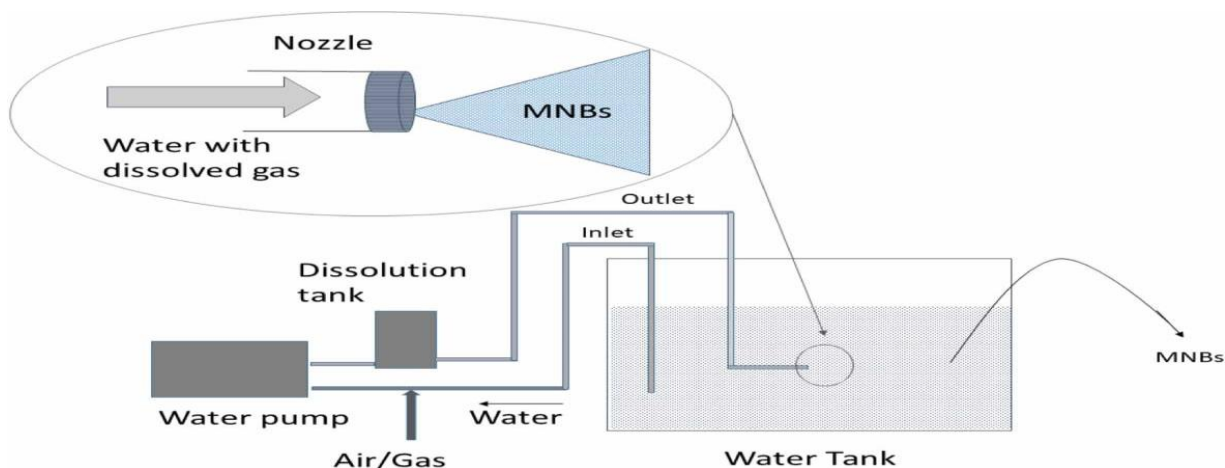


Fig1.3. Methodology of MNB generation.

The hydrodynamic cavitation mechanism is extensively employed to create NBs with the Venturi-type generator. The Venturi system is made up of three basic components: input flow, tubular output flow, and tapered output flow. By raising the speed of the fluid in the converging portions of the narrow diameter pipe, the pressure in the Venturi tube can be reduced. Both liquid and gas are passed through the Venturi tube simultaneously in order to produce bubbles in a Venturi-type producing system. Cavitation occurs when a pressurised liquid is delivered into the tubular component, increasing the fluid flow into the cylindrical throat while decreasing the input pressure. NBs are available in a variety of sizes (within several hundred nanometers).

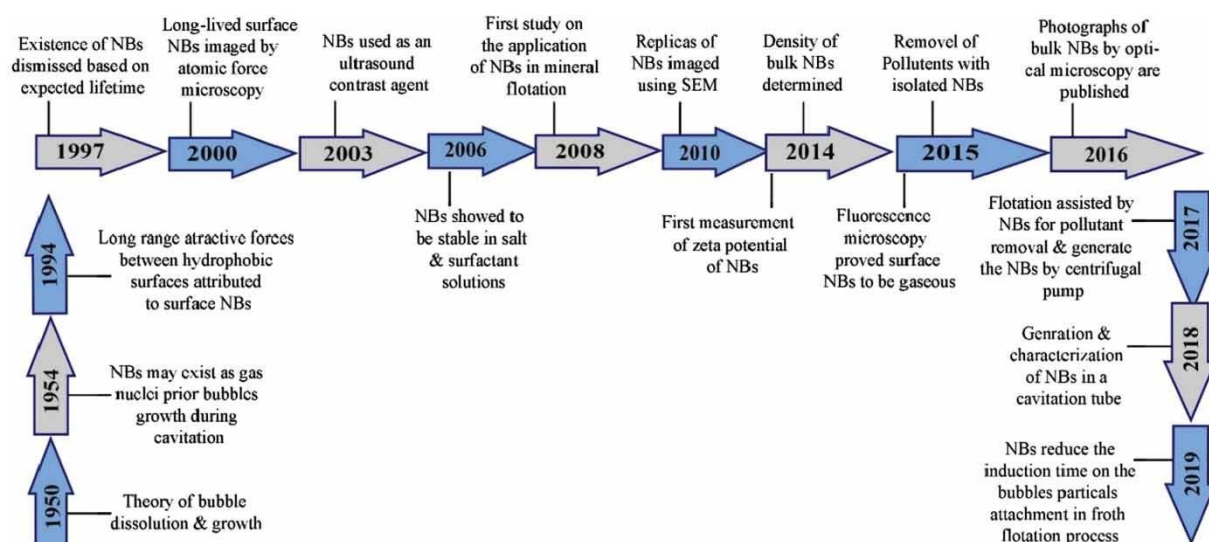


Fig 1.4. A timeline of the study and development of the MNB application.

An overview of MNB application research and development across time is shown in Figure 1.4. For the production of NBs between 130 and 545 nanometers, Ahmadi and Darban employed the hydrodynamic cavitation process. [16] Using hydrodynamic cavitation, Wu et al. created NBs as small as 500 nm. Cho et al. employed ultrasonication and a palladium electrode to create NBs with an average diameter of 300–500 nm. With octa-fluoro propane gas, Oeffinger& Wheatley found NBs with an average diameter of about 700nm after ultrasonication, according to the researchers

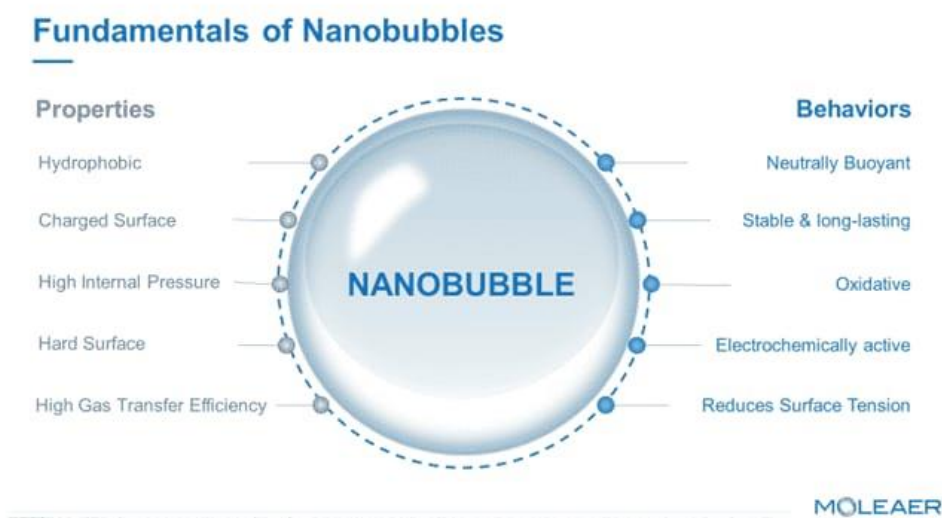


Fig 1.5. Fundamentals of Nanobubbles

Table 1.1 Advantages and disadvantages of commonly used MNB generation methods

	Method	Principle	Advantage	Disadvantage
Dissolving–releasing gas	Dissolving gas with pressure and releasing gas while reducing pressure	Dissolve the gas in water at high pressure and form a supersaturation state, then enter the gas to reduce pressure and form a large number of fine bubbles. The size and strength of the bubbles depend on the release conditions, including surface water tension.	At high pressure, the gas is highly soluble, so the number of bubbles <u>is</u> large and more bubbles rise stably.	The efficiency is low since the whole process is continuous.
	Dissolving gas with pressure and releasing gas with impeller	Fine bubbles are produced directly by the gas dispersed by the impeller, or in combination with the pressurized gas, performing three processes of mixing gas and water, releasing gas and gas dissolving.	Simple principle, efficiently produced in the combination of gas–water mixtures, more dissolution and release of the gas into the pump.	The process is complex, usually forms large bubbles (>50 μm).
Dispersing gas method	High-speed rotational flow	The gas–water mixture flows into the circulating hollow, forming a pressurized gas. The gas cuts into ultra-fine bubbles and rotates as the water passes.	Generally high quality and efficient.	The flow path is difficult to design and produce.
	Flow-path section change	The flow cross-section slowly decreases and then quickly increases; the water collapses violently and vortices are formed. Repeating the process leads to stronger turbulence and finer bubbles.	A large flow path makes it easy to repair and less likely to block up.	Difficult to adjust oxygen content during streaming significant changes in conditions.
	Fine porous materials	The pressure gas forms fine bubbles through the strength of small porous materials.	The quality of the bubbles mainly depends on the porous material. The method is simple.	Stuck frequently.

1.3 EFFECTS OF DIVERSE OPERATIONAL SITUATIONS ON BUBBLE LENGTH.

There is evidence to support the theory that the architecture of a device and the variety of operating circumstances affect the length and distribution of MNBs. MBs' percent and length, for example, are often linked to changes in the nozzle device's stress. Because of the increase in air density, bubble length decreases as a result of increasing stress. However, the duration of MBs remains constant above the stress level of 3. five atm, whilst the scale of the NBs is especially decided with the aid of using situations including the scale and the form of hose,

stress and sonic power. Even the kind of gas used to create the bubbles has an impact on how long NBs can be identified. For example, NBs can be detected for days using natural oxygen, while they can only be detected for less than an hour using air bubbles. Because of the smaller size of macrobubbles, using a fuel line with a larger molecular weight helps to balance out the density.

As far as synthetic characteristics, specialists have concentrated on the impacts of electrolyte arrangements (counting NaCl and other salt particles) and frothers (substance added substances) on seawater as for impeller speed and wind stream rate. High fueloline velocity (0.55 cm/s) and low impeller (4.2 m) speeds formed an 850-meter long bubble of sea salt solution, which was better than the sizes made with the help of frothers (600– 700 μm) in the experiment. Similarly, the interplay of salts and frothers has been discussed in relation to the evaluation of a particular impeller velocity and fueloline flow rate, which revealed that, Bubbles formed in sea salt solution with 0.5 M NaCl were much smaller than in deionized water without the use of a frother. With regard to the number of people who pay attention to frothers, As per research, introducing a small amount of frother to the mixture improved the results. (<10 ppm), The NaCl solution (0.5 M) created huge bubbles, whereas the electrolyte solutions over 10 ppm produced bubbles of similar length.

Further, research additionally as compared instances thinking about the ionic energy of the electrolyte solution in regard to the important coalescence attention. Results showed that the response of sea salt (0.7 ionic energy) created larger bubbles than the NaCl answer (0.5 ionic energy). Bubbles in sea salt solution grew in size due of the migration of salt ions in NaCl solution, according to this study. Many studies have used NaCl solution as a base with other salt ions (KCl, etc.) to analyse their influence on the size of the bubbles separately, and the results show that the varied salt ions had no major differentiation in the bubble length.

1.4 CHARACTERISTICS THAT MAKE NANOBUBBLE AN AERATION METHOD.

When compared to other kinds of bubbles, nanobubbles are very small

gas bubbles that have numerous unique physical characteristics. Nanobubbles are an excellent aeration solution for a variety of applications around the world due to these characteristics [17].

1.4.1 Neutral Buoyancy

According to comprehensive testing conducted by Using Malvern's Nano Sight Nanoparticle Tracking Analysis programme, nanobubbles have an average diameter of around 80nm. Bubbles of this size don't have enough buoyancy to reach the surface, therefore they move in Brownian motion instead. The nanobubbles float in the water for several months before dissolving, moving across randomly across the body of water and effectively aerating the entire column of water. As a result, the dissolved oxygen (DO) levels measured deep in the tank or pond will be the same as those measured above. Nanobubbles' unique behavior allows them to deliver a uniform distribution of oxygen throughout a body of water.

1.4.2 Surface charge

A surface charge is present in all bubbles by nature. The stronger the surface charge, the smaller the bubble. The electro kinetic potential in colloidal dispersions is called zeta potential, and nanobubbles have a high zeta potential. The significant negative charge of nanobubbles has been found to prevent their coalescence in zeta-sizer tests, implying that the bubble's integrity is sustained over long periods of time at any depth. Particles' negative charge and high concentration increase flotation separation efficiency by increasing collision chances. Wastewater, oil and gas and mining companies may now float more garbage than they could with old methods because of this innovative feature.

1.4.3 Gas Reserve

Nanobubbles can stay in suspension for months due to their neutral buoyancy and negative surface charge. Even when the solution is at 100% oxygen saturation, this occurs. A little amount of gas is held in reserve by the nanobubbles. The nanobubbles quickly diffuse new oxygen into the water when oxygen is taken from the water by biology, chemistry, or off-gassing, sustaining increased dissolved oxygen levels until the nanobubbles deplete. As much as a 20 percent over saturation gas reserve, firms may now utilise gas more cost effectively than before.

1.4.4 Surface Area

Surface area of nanobubbles is 400 times that of a typical microbubble, which has a diameter of 40 micrometers. Because of the higher surface area, mass transfer is increased, guaranteeing that almost any gas is effectively delivered to water.

1.4.5 Oxygen Transfer Efficiency

The efficient transmission of oxygen into the body of water is a critical need of any aeration application. Customary air circulation frameworks move only 1% to 3% of oxygen per foot of water due to their size and quick increment. Therefore, standard aeration is useless in the treatment of TB. The majority of the energy used for wastewater treatment comes from aeration, which is estimated to use between 1% and 2% of total global energy consumption [18].] The Nanobubble System's technology exploits nanobubbles' unique properties to deliver an industry-leading performance. Per foot of water, the oxygen transfer efficiency (OTE) is above 86%. When it comes to current aeration technology, nanobubbles are the most efficient and cost-effective option due to their extended water lifespan and enormous surface area per volume.

1.4.6 Oxidation

The zeta potential is a fundamental indication of colloidal dispersion stability. The stronger the zeta potential, the more stable the colloidal particle's behavior. A high zeta potential for nanobubbles indicates that they interact with colloidal particles more steadily and steadily stable than larger bubbles. Excess ions are produced as a result of the greater zeta potential, as are free radicals. When oxygen reacts with specific molecules, it can produce free radicals, which are electron-poor atoms, are odd-element atoms. Other chemical processes, such as combustion, atmospheric chemistry, polymerization, plasma chemistry, and biochemistry, also depend on free radicals for their operation.

1.4.7 Size of the bubbles

The smallest bubbles known are nanobubbles, which are 500 times

smaller than microbubbles, or about the size of a virus. The same amount of water may hold far more nanobubbles than it can with larger bubbles. Their tiny size allows for a variety of special qualities, including neutral buoyancy and a strong electric charge. They also have a high transmission efficiency. Larger bubbles do not have the same properties as nanobubbles, making them less effective in a number of contexts.

1.5 Application of MNB technology in water treatment

1.5.1 Aeration in water

As a biological reaction substrate for the decomposition of oxidative pollutants, oxygen is an essential component of water treatment. Aeration is thus necessary for the transportation of oxygen in the water supply. However, while traditional ventilators require large amounts of electricity, oxygen transfer efficiency is only 610%. Using MNB instead of traditional aeration bubbles can promote mass transfer of raise dissolved oxygen content and accelerate oxidation by increasing the amount of air in the atmosphere. Conventional bubble aeration systems' oxygen usage and mass transfer coefficient are about doubled by synthetic wastewater treatment systems using MNB aeration. The effects of MB aeration and conventional aeration on Black Doll River water treatment were investigated. At the same level of aeration, MB produces more dissolved oxygen than any other method (DO). After 60 minutes of aeration, the MB and normal aeration DO concentrations were 9.87 mg / L and 6.54 mg / L, respectively. Aeration increased the concentrations of COD (12%), NH₃N (10%), Geosmin (16%), and 2-methylisoborneol (12%), respectively.

4.2.

1.5.2 Degradation of organic pollutants and disinfection of water

Not only does MNB's high mass transfer efficiency boost the usage of chemicals, but it also produces hydroxyl radicals when it decomposes and reacts directly and non-selectively with organic pollutants. MNBs produced by hydraulic cavitation have been widely proven to be able to effectively increase the oxidative breakdown of organic contaminants that are resistant to current methods. Chu et al. As a result of our research, we were able to demonstrate an 80 percent improvement

in total mass transfer coefficient of ozone and a 30% increase in TOC removal rate using wastewater simulated with azo dyes. This was the name given to Li Panetal. MB produced by cavitation was used to investigate the degradation process of phenol and nitrobenzene as model organic contaminants. Aeration of roughly 70 MB uses just 50 percent of the ozone required by typical bubble aeration, a mass transfer rate of 1.31.5 times. Traditional bubbling requires this. Phosphor degradation is comparable with the principal reaction rate, although MB seems to have an even faster disintegration period than traditional bubbles. In addition, studies of the effects of MB on enteric pathogens have shown that hydroxyl radicals and shock waves produced by the degradation of MB are believed to be the major causes of coliform inactivation.

1.5.3 Flotation with MNBs

As a solid-liquid separation method, air levitation has become an important tool in the treatment of trace contamination and industrial wastes. As a transporter for contaminants in wastewater, air flotation uses precipitated, highly scattered microbubbles precipitated from water. The produced floc is then transferred utilising buoyancy. Solid liquid effective separation may be achieved using MNBs because of their unique features of wide surface area, high zeta potential, and extended residence time in water, which promotes longer contact time and increased adhesion efficiency of bubbles and suspended particles. Using both standard bubbles and MNBs, Liu et al. tested printing and dyeing wastewater treatment using air flotation technology and found that MNB air floatation technology speeds up pretreatment and decreases flocculants efficiently. Oil, COD, and chroma removal rates are %, 30 %, and 110 % greater, respectively, compared with a regular bubble air flotation method.

1.5.4 Membrane cleaning

Using MNBs, which are non-toxic and kind to the environment, you can keep surfaces clean and keep contaminants like bovine serum albumin from sticking to the mica surface. You can also use MNBs to remove organic pollutants from HOPG without harming it. In addition, the combination of low-power, high-frequency ultrasound and MNB has shown considerable promise for inhibiting the adhesion of bacteria and algae to solid surfaces. Dayarathneetal. Solute removal

using reverse osmosis membranes may be improved by increasing the air MNB's permeation flux, TMP (penetration pressure), and solute removal rate. Concentration polarisation layers were efficiently eliminated or prevented from accumulating by MNB. Solute removal was enhanced by 0.8 percent, whereas permeation flux rose 24.62 per cent. Recovering membrane permeation flux may also be achieved at 100% using simple physical purification techniques. The adsorption rate of bovine serum albumin (BSA) on the MNB-modified HOPG surface produced by Hu Jun et al. 20 seconds of electrochemical treatment is 66% 74%, which is 26% higher than that of the unmodified HOPG surface MNB. % 34% lower was observed by AFM. Figure 1.5.1(b). Following a 50-second electrochemical treatment, BSA's coverage was decreased to 82 percent after BSA was entirely adsorbed on the surface. Viewed from the top, Figure 1.5.1 (d). The advancing three-phase line causes the NB generated between the HOPG and the BSA layer to convey the adsorbed protein from the solid-liquid to the liquid-air interface when seen in situ. It was rumoured that it was carried out. Low shear flow, on the other hand, reduces protein instability at the liquid-air interface.

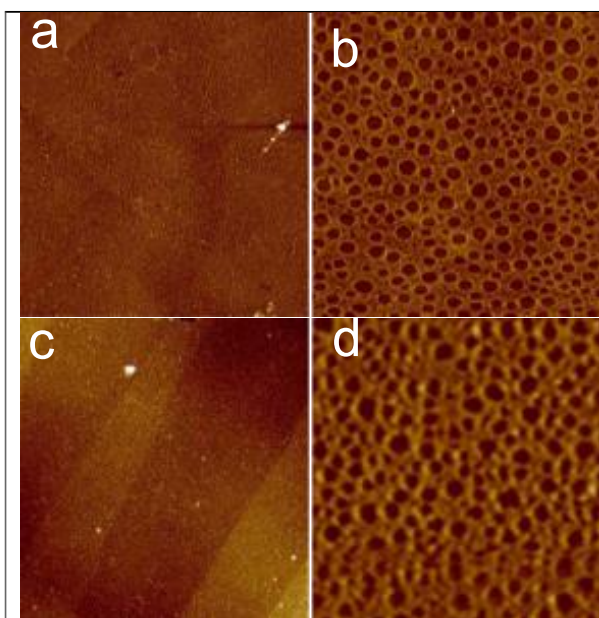


Fig 1.6. BSA protein absorbed on HOPG. (a)without MNBs, (b)with MNBs; before(c) and after(d) electrochemical treatment to produce MNBs

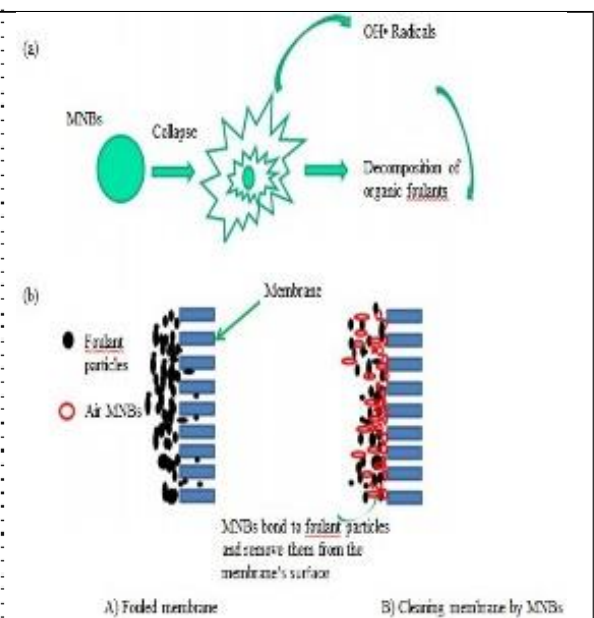


Fig 1.7. (a)Principles of MNBs to generate hydroxyl radicals; (b) cleaning effect of MNBs

CHAPTER – 2

LITERATURE REVIEW

Use of nanobubbles generated by Ionization in waste water treatment. In order to entirely or partially purify the water, a new technique is constantly needed." When the water is introduced into the correct system, it will be disinfected in a much larger volume than it was before. Easy to use and inexpensive compared to other systems on the market, this system is a great option. Case Study on Nanobubbles Technology for Heat Transfer Enhancement to Ethylene Glycol Coolant Oil. In this research, the heat transfer potential of Ethylene Glycol ($C_2H_6O_2$), a coolant for car radiator nanofluids is investigated experimentally due to its excellent anti-freezing characteristics. The tested fluid is a mixture of water and ethylene glycol with 50:50 proportions by volume. Thermal energy conservation, conversion, and recovery all rely on the use of heat exchangers in the process Technology for water and wastewater treatment using ozone micro nanobubbles [1].

This article gives an overview of the use of micro- and nano bubble ozonation in water and wastewater treatment. Hydrodynamic ozonation of synthetic aqueous solutions and a wide range of industrial wastewaters is examined in detail, as are the drawbacks of previously investigated approaches. Nanobubbles and their usage in wastewater treatment are covered in this article. As far as bubble size and stability are concerned, nanobubbles are widely considered to be of importance. These small, spherical-capped bubbles exhibit a wide range of unusual properties in terms of mechanics and mechanics [2].

The use of ozone micro-nano-bubbles for ground water treatment. Using MNBs, this study shows how effective water-based gas supply and mass transfer systems may be. The ozone MNBs approach was used to remediate an organics-contaminated site's ground water in situ. Nanobubbles in aqueous solutions being studied for many purposes. This document lists the easiest methods for producing nanobubbles in various aqueous solutions, as well as their uses. All of the water samples were analysed for chemical oxygen demand and biochemical oxygen demand, as well as for total suspended particles and the concentrations of suspended solids and dissolved oxygen [4].

concepts and uses of water treatment using microbubble or nanobubble technology. Free radical generation from micro- and nanobubbles, as well as the physics and methodologies for creating them, are all explored in this study. The research also looks at how these micro- and nanobubbles break down hazardous compounds, disinfect water,

and clean/foul solid surfaces, including membranes. Because of their ability to create free radicals, MBs and NBs are believed to have enormous future potential, with much more to be discovered. Submicron bubbles are generated and characterised.. The length of agitation and the temperature had only a little impact on the production of submicron bubbles. Surface features such as zeta-potential and submicron bubble stability were discovered to be extremely important [5].

Micro-nano bubbles in water treatment: basic properties and applications. MNBs have been used in water oxygenation, pollutant degradation, and membrane cleaning. MNBs are likely to benefit from these studies in terms of theoretical research as well as practical application.[6]

Using micro-nano bubbles for groundwater cleanup. MNBs technology may be used to remediate polluted groundwater bodies, according to this article. Final thoughts on MNB groundwater remediation limitations and challenges are offered. Treatment of Drinking Water Using Nano-Ozone Bubbles Commercial-scale nanobubble generation techniques are summarised in this manuscript, and a way for using ceramic diffusers in a more efficient treatment facility is offered. Furthermore, a cost-benefit analysis highlighting the advantages of using ozone as nanobubbles was given [7].

Fundamentals and practical uses of nanobubbles A comparison of mechanical agitation versus sonication for the formation of microbubbles. Two popular ways of generation, mechanical agitation and sonication, are examined in this study to see how effective they are. Results showed that sonication generated microbubbles more effectively than mechanical agitation in terms of increased gas hold-up, smaller bubbles and bigger interfacial areas [8].

Bioethanol may be produced via a yeast propagation–fermentation method with microbubble sparging. The conclusions reached relate to the zeta potential measurement and the techniques used to get it [9].

In terms of water treatment, micro and nanobubble technologies provide up new possibilities. Microbubbles and nanobubbles are the focus of this review article, with a particular focus on water treatment. Based on several researchers' descriptions,

these are the fundamental definitions of bubble kinds and their corresponding size ranges [10].

NBs provide chances to enhance existing or enable new water treatment methods, according to this article, which will result in fewer by-products and cleaner water for users. principles and applications of water purification using micro- and nano-bubbles Micro- and nanobubbles in water purification are discussed in this work, along with the physics and techniques for producing them, as well as the formation of free radicals from these micro- and nanobubbles, including the membrane effect and their usage in water disinfection [11].

Flotation, aeration, and ozonation are just a few of the classic and cutting-edge methods used in this research to purify water and oxidise organic pollutants while simultaneously removing impurities and colourants. As a platform for the effective removal of dangerous elements from water, bubble technology has evolved. [12].

CHAPTER – 3

AIM AND SCOPE OF PRESENT INVESTIGATION

3.1 AIM.

The main goal of this work is to use nanobubble technology to purify water from sea, and reduce tds of sea water using natural method. In addition to the various technologies that exist in the world today, such as reverse osmosis and distillation, for purification of waste water treatment nanobubble technology is the modern strategy for the refinement of wastewater. Nanobubble technology is an up-and-coming technology with a wide range of applications.

3.2 SCOPE

We humans pollute water for our desires and uses. So we need effective methode for waste water treatment rather than old methodes like reverse osmosis and distilation. Like micro nano bubble technology because of its low complexity and cost effectiveness. This nanotechnology is a technology that is emerging in today's world. Therefore, they are used to purify seawater.

Micro–nanobubbles have gotten a lot of interest lately because of their distinctive properties. Micro–nanobubbles The processes of MNB generation up till now. In other fields, however, it seems that MNB application trends are more promising

In addition to water treatment, the use of MNB has considerable environmental sustainability potential because of its better time-cost efficiency and decreased chemical usage. Water treatment procedures including disinfection and flotation might benefit from MNBs' unique qualities such as increased mass transfer rate (MTR), collision efficiency, reduced rising velocity, bespoke surface charge, and radical production.

Such treatment is projected to have a high time-cost efficiency in terms of greater organic pollutant separation, flotation, aeration efficiency for biological treatments, and accelerated oxidation employing OH radicals. Ozone-based MNB usage for the oxidation process may benefit greatly from the chemical-free radical

production feature. Additionally, the increased bursting energy and improved aeration efficiency of MNBs have the potential to reduce membrane fouling and sludge formation in membrane bioreactors.

MNB technology may also concentrate on the optimization and automation of MNB generators in order to tailor the generating mechanism in different industries, such as industry and agriculture. MNB-based water treatment, for example, may benefit from increased automation and control based on smart technologies to meet the rising need for water treatment at all sizes.

Finally, despite the enormous promise of MNBs as a smart, efficient, and cost-effective therapeutic technique, its use is currently restricted to the laboratory. It is thus necessary to concentrate future research and initiatives on the development and use of this technology on a large-scale in agriculture and industrial sectors.

CHAPTER - 4

MATERIALS AND METHODS

Nanobubble generator and seawater and Thethankotai powder are the components used in this method. To begin, we gathered seawater from ECR BEACH (Chennai).



Fig 4.1 Seawater Sample.

The seawater sample above as shown in fig 4.1 was taken from seawater collected from ecr beach . The water is now being tested for purity. And I requested several tests from the Chennai Mettlex lab private limited, which is located near Guindy in Chennai. pH reading at 25 degrees, dissolved oxygen content (DO), total amount of dissolved solids (TDS), present in the sample, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), salinity. As stated in the table below, are the values reported.

Table 4.1. These are the test findings for the seawater sample (before purification).

Sl.No	Test parameters	Results
1.	pH at25°C	8.06
2.	Dissolved Oxygen (DO)	5.76 mg/l
3.	Total Dissolved Oxygen (TDS)	41920 mg/l
4.	BOD at 27°C for three days	4 mg/l
5.	COD	17 mg/l
6.	SALINITY	33.84%

We can confirm that the seawater from sea is contaminated based on the preceding test results as shown in above table 4.1. The key goal now is to use nanobubble technology to purify this seawater and reduce TDS AND SALINITY. As a result, the first and most important step is to create nanobubbles. The technique of hydrodynamic oxidation is used to create nanobubbles. The figure 4.2 is the equipment for nanobubble generation. A motor, inlet valves, outlet valves, a nozzle, and a pressure regulator these are the equipment's used for MNB generation.

To provide a controlled flow of air, the amount of air to be drawn from the oxygen cylinder is adjusted using an inlet valve. So that nanobubbles can be generated in a controlled manner in the water. Bulk nanobubbles, micro-nanobubbles, and macro-nanobubbles are among the nanobubbles produced. The figure 4.3 shows the inlet valves in which the pressure is regulated and the figure 4.4 shows the motor.



Fig 4.2 Nanobubble Generation Equipment

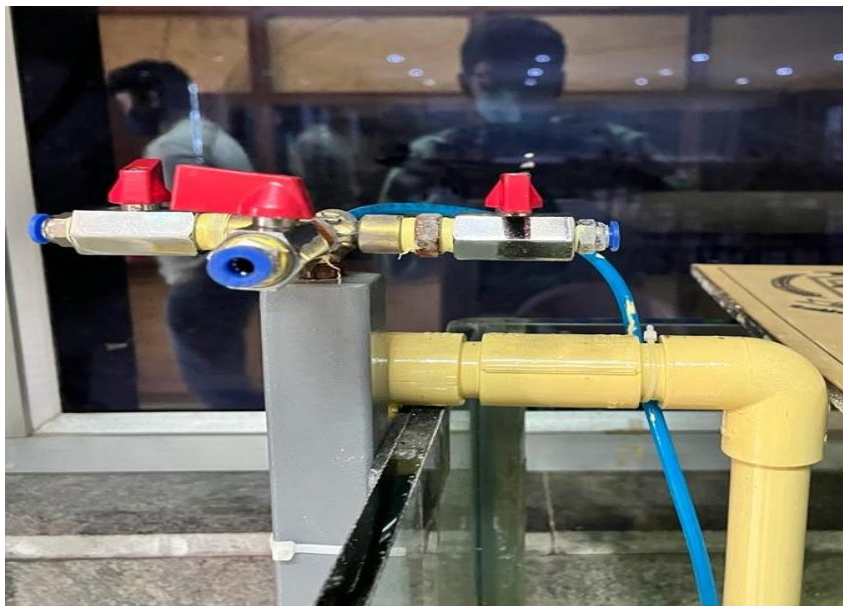


Fig 4.3 Inlet Valves



Fig 4.4 Motor

- Collected sea water in cans is filled in nanobubble generator process has been done in the nanobubble generator device as shown in fig 4.2.



-
- Samples collected in one litre bottles, sample are collected at regular intervals one hour, 2hours, 3hours, 4 hours samples during process as shown in fig 4.5.



FIG 4.5 COLLECTING WATER SAMPLES FROM NANO BUBBLE GENARATOR



- The sample is add with clearing nut powder for 24hours and 48 hours and 72hours,after filtration of each sample, the sample are given for test to see whether there is reduce in TDS or not in Chennai falcon industries (perungudi)complete results are out.
- 100% practical work is completed in sathyabama institute of science and technology.

CHAPTER - 5

RESULTS AND DISCUSSION

5.1 RESULTS.

ORIGINAL SAMPLES: RESULT

Table 5.1 ORIGINA SEA WATER SAMPLE

S.No	TEXT PARAMETERS	PROTOCOL	RESULTS
1	pH at 25°C	IS 3025 Part 11:1983 (Reaff: 2017)	8.06
2	Dissolved Oxygen (DO)	IS: 3025 Part 38-1989 (Reaff.2014)	5.76 mg/l
3	Total Dissolved	IS 3025 Part 16:1984 (Reaff: 2017)	41920 mg/l
4	BOD at 27°C for 3 days	IS 3025 Part 44:1993 (Reaff: 2014)	4 mg/l
5	COD	IS 3025 Part 58:2006 (Reaff: 2017)	17 mg/l
6	SALINITY	By Argentometric Titration	33.84 %

Case 1: 1 Hour Sample:

Table 5.2 one hour sample

S.no	TEXT PARAMETERS	PROTOCOL	RESULTS
1	pH at 25°C	IS 3025 Part 11:1983 (Reaff: 2017)	7.62
2	Dissolved Oxygen (DO)	IS: 3025 Part 38-1989 (Reaff.2014)	5.9mg/l
3	Total Dissolved	IS 3025 Part 16:1984 (Reaff: 2017)	36440 mg/l
4	BOD at 27°C for 3 days	IS 3025 Part 44:1993 (Reaff: 2014)	BDL(DL2.0 mg/l)
5	COD	IS: 3025 Part 58:2006 (Reaff:2017)	16 mg/l
6	SALINITY	By Argentometric Titration	32.2%

pH reading at 25 degrees centigrade is 7.62, dissolved oxygen content (DO)

is 5.9mg/l, total amount of dissolved solids (TDS) is 36440mg/l, present in the sample, Biological Oxygen Demand (BOD) is BLD(DL:2.0mg/l), Chemical Oxygen Demand (COD) is 16, salinity is 32.2%. Here TDS is reduces from 41920 to 36440mg/l as shown in table 5.2.

Due to reduce in TDS there is reduce in salinity percentage because TDS and salinity are directly proportional to each other. Salinity reduces to 33.84% to 32.2%.

Case 2: 4 Hour Sample:

Table 5.3 Four hours Sample

SINO	TEST PARAMETERS	UNIT	TEST METHODS	RESULTS
1	TDS	MG/L	IS:3025 (part - 16):1984 (Reaffirmed 2017)	33275

Collected sea water is treated in naano bubble generator for four hours and the sample is collected in one litre water bottle and given for testing in chennai falcon industries lab perungudi for total dissolved solids.

RESULTS: total dissolved soids value is 33275mg/l here the value is reduced again from one hour to four hour sample .so, TDS of sea water is reduce as time of treatment of sea water in nanobubbles increases and salinity is also reduces due to reduction of TDS.

Reduction of TDS using Natural Method by adding Powder to the Seawater treated with nanobubbles.

Case 3: water treated with nanobubbles and contains murugai vidhai powder

Collected sea water is treated in nanobubble generator for four hours and the sample is collected in one liter water bottle and added with murugai vidhai powder and leaves it for 24 hours and after filtration given for testing in Chennai falcon industries lab perungudi for total dissolved solids

RESULTS: TDS value is 37945mg/l there is no use for using this powder

Table 5.4 Water contains murugai vidhai powder

SAMPLE DETAILS				
Sample Description: Water contains murugai vidhai powder				
SL.NO	TEST PARAMETERS	UNITS	TEST METHOD	RESULTS
1	Tds after Filtration	mg/l	IS:3025 (part - 16):1984 (Reaffirmed 2017)	37945

Case 4: water treated with nanobubbles and thethankotai powder

Collected sea water is treated in nanobubble generator. The sample is collected in one liter water bottle and added with clearing nut powder and leave it for 24 hours and after filtration given for testing in Chennai falcon industries lab perungudi for total dissolved solids

RESULT: TDS value is 34478mg/l

Table 5.5 Water contains thethankotai powder (24 Hours)

SAMPLE DETAILS				
Sample Description: Water contains the than kota i powder				
SL.NO	TEST PARAMETERS	UNITS	TEST METHOD	RESULTS
1	Total Dissolved Solids	mg/l	IS:3025 (part - 16):1984 (Reaffirmed 2017)	34478

Case 5: water treated with nanobubbles and thethankotai powder

Collected sea water is treated in nanobubble generator. The sample is collected in one liter water bottle and added with clearing nut powder and leave it for 48 hours and after filtration given for testing in Chennai falcon industries lab perungudi for total dissolved solids

.RESULT:TDS value is 31491mg/l

Table 5.6 Water contains thethankotai powder (48 Hours)

SAMPLE DETAILS				
Sample Description: Water contains thethankotai powder				
SL.NO	TEST PARAMETERS	UNITS	TEST METHOD	RESULTS
1	TDS after Filtration	mg/l	IS:3025 (part - 16):1984 (Reaffirmed 2017)	31491

Case 6: water treated with nanobubbles and thethankotaipowder

Collected sea water is treated in nanobubble generator. The Sample is collected in one liter water bottle and added with clearing nut powder and leaves it for 72 hours and after filtration given for testing in Chennai falcon industries lab perungudi for total dissolved solids.

RESULT:TDS value is 30638mg/l

Table 5.7 Water contains thethankotai powder (72 Hours)

SAMPLE DETAILS				
Sample Description: Water contains thethankotai powder				
SL.NO	TEST PARAMETERS	UNITS	TEST METHOD	RESULTS
1	TDS after Filtration	mg/l	IS:3025 (part - 16):1984 (Reaffirmed 2017)	30638

EXPLANATION FOR CASE: 4, 5, and 6

In the above three cases the sea water is first treated with nanobubbles and added the clearing nut powder after that samples are leaved for 24, 48, 72 hours respectively each sample is tested after filtration in Chennai falcon industries lab and there is decreases in the total dissolved solids of each sample. Sodue to decreases in tds we can say there is decreases in salinity of sample .so here the tds is decreases trough nanobubble treatment and natural method by adding powder.

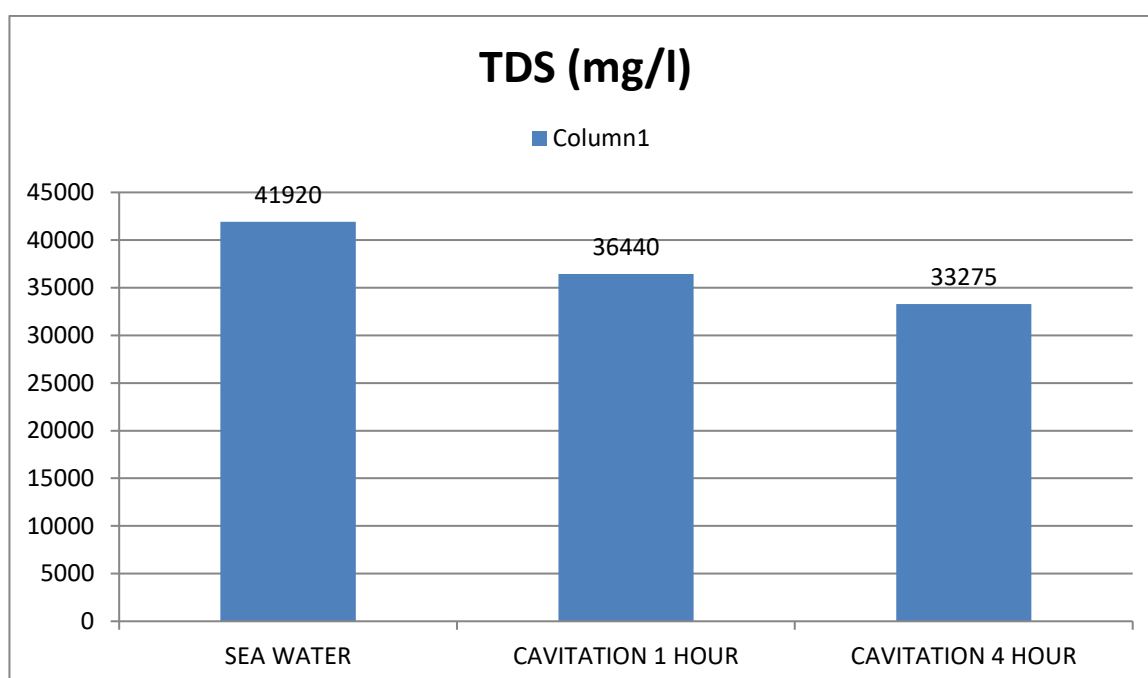


FIG 5.1 COMPARISON OF TDS FOR ORIGINAL SEA WATER AND SEA WATER CAVITATION PROCESS

In the above fig 5.1 graph there is comparison of total dissolved solids from sea water to sea water treated with micro nanobubbles technology under cavitation process with respect to time. The x-axis represents the samples of sea water and y-axis indicates the values of total dissolved solids IN milligram per liter. Here we can see the sea water tds is very much. Its value is 41920mg/l when it is treated in micro nanobubble technology without entry of air for almost one hour and given this sample for testing in mettex. Its value becomes reduced to 36440mg/l and after the sample is treated in micro nanobubble generator of 4 hours and given for testing in falcon industries .now as we can see its value in the graph reduced to 33275mg/l. from graph we can observe the tds is reduced from original sample to 4 hours treated sample.

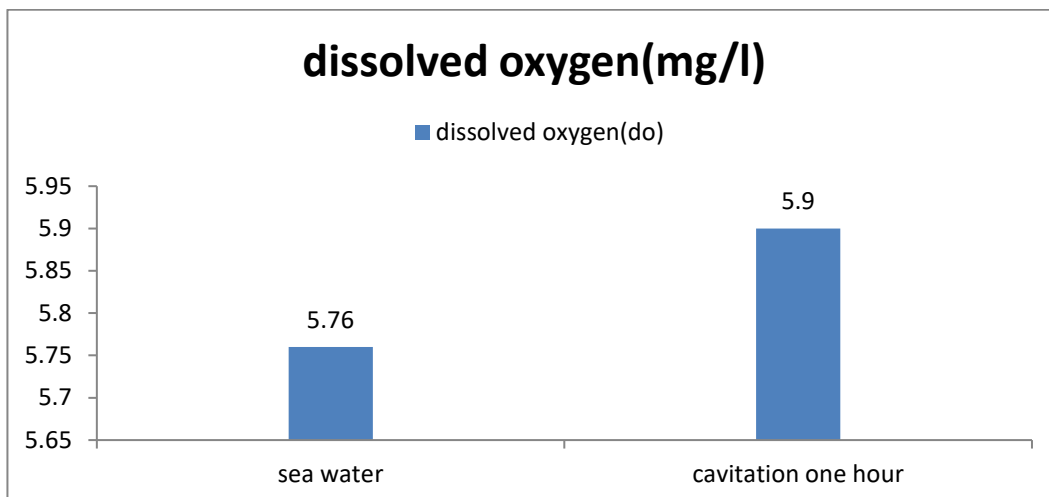


FIG 5.2 COMPARISON OF SEA WATER DISSOLVED OXYGEN AND SEAWATER TREATED WITH MNB'S UNDER CAVITATION PROCESS

In the above fig 5.2 graph x-axis represents the samples and y-axis represents the dissolved oxygen. Dissolved oxygen means amount of oxygen dissolved in the water and it is measured in milligram per liter. Here as we can see the do content of Sea Water is 5.76 it is increased to 5.9 after treated with mnb's in mnb's Generator device under cavitation process. We can say that amount of oxygen presents increases. Increases of oxygen content refer to the quality improvement of water.

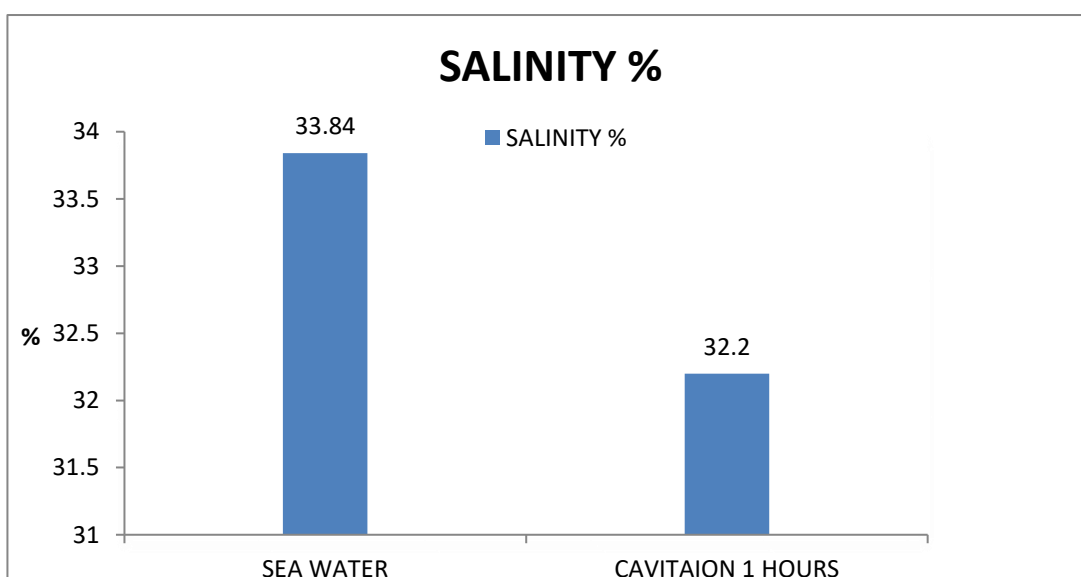


FIG 5.3 COMPARISON OF SEA WATER SALINITY AND SEAWATER TREATED WITH MBN'S UNDER CAVITATION

PROCESS

In the above graph x-axis represents the samples and y-axis represents the salinity. Salinity means the concentration of salt in water and its value is indicated in terms of percentage. As we can see from above graph salt concentration of original sea water is 33.84% which is further reduced to 32.2% when it is treated with MnB's in MnB's generator device under cavitation process. Although we can say if there is a reduction in TDS value the salinity percentage also reduces because TDS and salinity are directly proportional to each other.

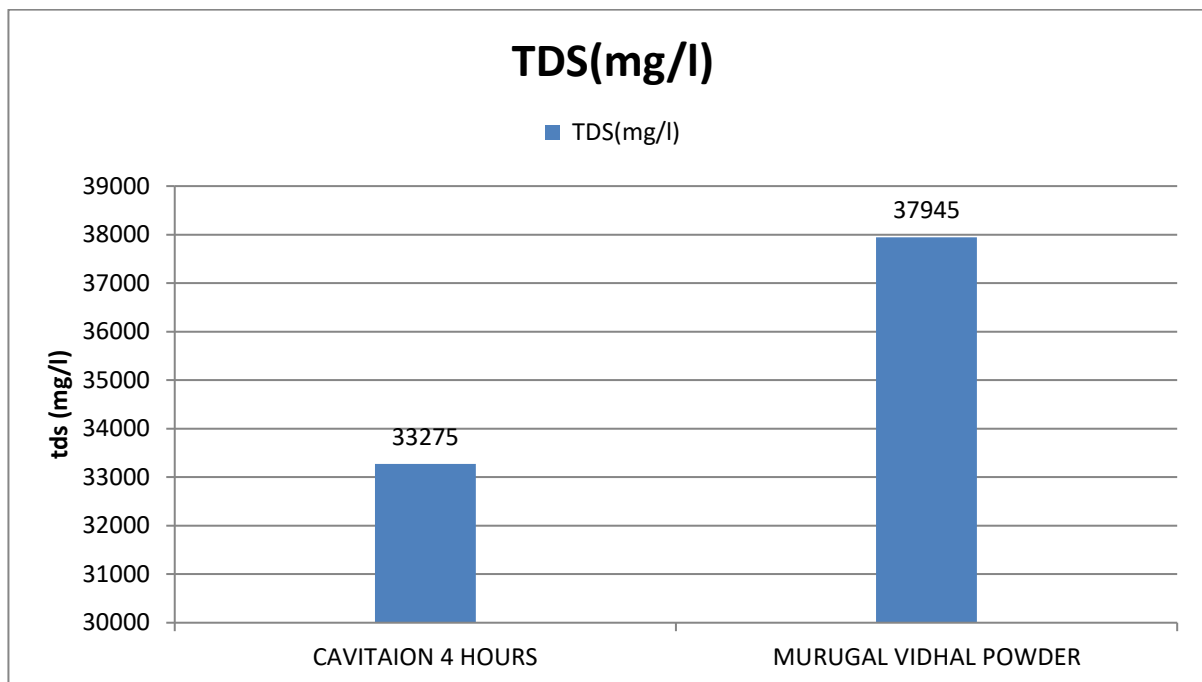


FIG 5.4 COMPARISON OF SEA WATER TDS FOR SAMPLE IN CAVITATION PROCESS AND SAMPLE ADDED WITH MURUGAL VIDHAL POWDER

In the above graph x-axis represents the samples and y-axis represents the TDS and it is measured in milli gram per liter (mg/l). Here the graph represents the increase in the total dissolved solids but we require the reduction from its original value. TDS value is increased from 33275 mg/l to 37945 mg/l, which shows there is no use of using the Murugul Vidhal powder as a reagent in the reduction of TDS of sea water. As the TDS is not reduced there will be no reduction in the salinity because salinity and TDS

are directly proportional to each other. To conclude that there will be no reduction in tds and salinity by using muruga vidhal powder in water treated with micro nanno bubbles in mnb generator device.

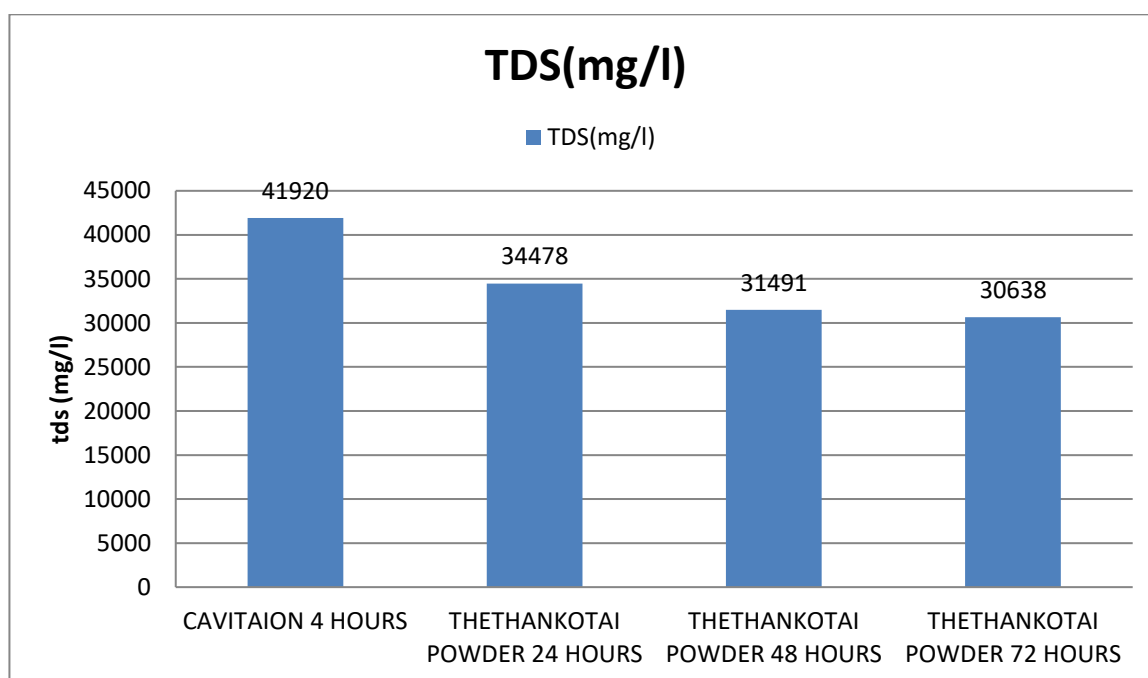


FIG 5.5 COMPARISON OF TDS IN SEA WATER FROM CAVITATIONS SAMPLE TO THETHANKOTAI POWDER ADDED SAMPLE WITH RESPECT TO DURATION OF TIME

In the above graph x-axis represents the samples and y-axis represents the TDS and it is measured in milli gram per liter(mg/l). Here the graph represents the reduction of TDS from sample to sample with respect to time.

In the above cases the sea water is first treated with micro nanobubbles under cavitation process for four hours its value is 33275mg/l and added the clearing nut powder after that samples are left for 24, 48, 72 hours respectively. Each sample is tested after filtration in Chennai falcon industries lab and there is a decrease in the total dissolved solids of each sample. For the first day 24 hour sample the total dissolved solids value is 34478mg/l, The second day 48 hours the TDS value 31491mg/l and at last for 72 hours the TDS value is 30638mg/l. as we can see here the TDS is declined from each sample which indicates the improvement of the quality of water. so when we treated with MNB's and added clearing nut powder the tds value is reduced. Which shows nanobubbles play a prominent role in water purification or desalination of sea

water.

5.2 DISCUSSION.

After analyzing the characteristics of nanobubbles and determining the bubble number density, bubble diameter, and dissolved oxygen content, we are now moving on to the next phase, which is determining the extent to which water may be purified utilizing nanobubble technology. The water collected after the micro nanobubbles are created is delivered to a laboratory. pH reading at 25 degrees, dissolved oxygen content (DO), total amount of dissolved solids (TDS), total suspended solids (TSS), amount of phosphate content, amount of chromium content, amount of sulphides present in the sample, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), The test results are now available after a week. And the tests results are shown in the above figure. we can see that after the results came sea water TDS is very much. Its value is 41920mg/l when it is treated in micro nanobubble technology without entry of air for almost one hour and given this sample for testing in mettex. Its value becomes reduced to 36440mg/l and after the sample is treated in micro nanobubble generator of 4 hours and given for testing in falcon industries. Now as we can see its value reduced to 33275mg/l. from this we can observe the TDS is reduced from original sample to 4 hours treated sample. the sea water is first treated with micro nanobubbles under cavitation process for four hours its value is 33275mg/l and added the clearing nut powder after that samples are leaved for 24, 48, 72 hours respectively. Each sample is tested after filtration in Chennai falcon industries lab and there is decreases in the total dissolved solids of each sample. For the first day 24 hour sample the total dissolved solids value is 34478mg/l, the second day 48 hours the TDS value 31491mg/l and at last for 72 hours the TDS value is 30638mg/l. as we can see here the TDS is declined from each sample which indicates the improvement of the quality of water .so when we treated with MNB's and added clearing nut powder the TDS value is reduced. Which shows nanobubbles plays a prominent role in water purification or desalination of sea water.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1. SUMMARY.

There are many disciplines of science and engineering that use nanoscale phenomena in the design, characterization, production, and application of materials as well as devices and systems. Water treatment techniques are increasingly incorporating nanotechnology. The technique of manipulating atoms on a nanoscale is known as nanotechnology. In nanotechnology, nano membranes are used to soften water while also eliminating pollutants like physical, biological, and chemical contaminants. It is possible to make nanobubbles utilizing hydrodynamic oxidation. After that, the nanobubbles will be used to remediate ground water. After that, the water is transported for testing to determine its quality. The results are then used to conduct some analysis.

6.2. CONCLUSION.

MNB is a promising technology that has been used to a broader number of industries in the previous decade, including energy, environment, industry, agriculture, and aquaculture.

Here When tiny nanobubbles are created, the water is purified to some extent. Micro nanobubble technology may be utilised in wastewater and other water purification operations to enhance water quality, as evidenced by a percent increase in dissolved oxygen concentration in the water. However, progress has been made and several explanations for NB long-term stability have been offered, none of which satisfactorily explains the experimental finding.

Finally, this research intends to learn more about how to increase performance approaches, bubble development and size under different physical and chemical circumstances, bubble formation methods, and automated optimization.

REFERENCES:

- 1 Achaoui Y., Metwally, K., Fouan, D., Hammadi, Z., Morin, R., Debieu, E., Payan, C., Mensah, S., 2017. Tunable microbubble generator using electrolysis and ultrasound. *AIP Advances* 7, 015011.
- 2 Alheshibri M, Qian J, Jehannin M, Craig VSJ (2016) A history of nanobubbles. *Langmuir* 32(43):11086-11100. <https://doi.org/10.1021/acs.langmuir.6b02489>
- 3 Ashutosh Agarwal; WunJern Ng; Yu Liu (2011). Principle and applications of microbubble and nanobubble technology for water treatment. , 84(9), 1175–1180. doi:10.1016/j.chemosphere.2011.05.054
- 4 Atchley AA, Prosperetti A (1989) The crevice model of bubble nucleation. *J AcoustSoc Am* 86(3):1065-1084. <https://doi.org/10.1121/1.398098>
- 5 Atkinson AJ, Apul OG, Schneider O, Garcia-Segura S, Westerhoff P (2019) Nanobubble technologies offer opportunities to improve water treatment. *AccChem Res* 52(5):1196-1205. <https://doi.org/10.1021/acs.accounts.8b00606>
- 6 Azevedo A, Etchepare R, Calgaroto S, Rubio J (2016) Aqueous dispersions of nanobubbles: generation, properties and features. *Miner Eng* 94:29-37.
- 7 Batagoda JH, Hewage SA, Meegoda JN (2019) Nano-ozone bubbles for drinking water treatment. *J Environ EngSci* 14(2):57-66.
- 8 Boshenyatov BV, Kosharidze SI, Levin YK (2019) On the stability of nanobubbles in water. *Russ Phys J* 61(10):1914-1921.
- 9 C.Rameshkumar, S. LakshmiSankar, G. Senthilkumar, Characterisation of seed germination using nanaobubbled water, *Int. J. Ambient Energy* (2019), <https://doi.org/10.1080/01430750.2019.1672581>.
- 10 Daryabor, M., Ahmadi, A., Zilouei, H., 2017. Solvent extraction of cadmium and zinc from sulphate solutions: Comparison of mechanical agitation and ultrasonic irradiation. *UltrasonicsSonochemistry* 34, 931–937.
- 11 Fan, M.; Tao, D.; Honaker, R.; Luo, Z. Nanobubble generation and its application in froth flotation (part I): Nanobubble generation and its effects on properties of microbubble and millimeter scale bubble solutions. *Min. Sci. Technol.* 2010, 20, 1–19.
- 12 Fan, W., An, W., Huo, M., Yang, W., Zhu, S., Lin, S., 2020. Solubilization and stabilization for prolonged reactivity of ozone using micro-nano bubbles and ozone-

saturated solvent: A promising enhancement for ozonation. Separation and Purification Technology,

- 13 G Senthilkumar, AM Rakesh, BRS Aravind Sri Krishna, Nivin Joy, S Ganesan, J Hemanandh (2020) Experimental investigation on the effect of nanobubbled water in evaporative cooling and oxygen enrichment in air cooler Materials Today: Proceedings doi.org/10.1016/j.matpr.2020.09.759,44(5), pp.3622-3626.
- 14 Geisse, N.A., 2009. AFM and combined optical techniques. Materials Today,
- 15 H. Joost, Weijs and Detlef Lohse, why surface nanobubbles live for hours Physical review letters, 110(5), (2013) 054501.
- 16 H. Tsuge, Fundamental of microbubbles and nanobubbles, Bulletin of the Society of Sea Water Science Japan 64 (2010) 4–10
- 17 Huang, J., Sun, L., Liu, H., Mo, Z., Tang, J., Xie, G., Du, M., 2020. A review on bubble generation and transportation in Venturi-type bubble generators. Exp. Comput. Multiph. Flow 2, 123–134.
- 18 Jin, J., Feng, Z., Yang, F., Gu, N., 2019. Bulk Nanobubbles Fabricated by Repeated Compression of Microbubbles. Langmuir 35, 4238–4245.
- 19 Kang, B.-K.; Kim, M.-S.; Park, J.-G. Effect of Dissolved Gases in Water on Acoustic Oxidation and Bubble Growth Rate in 0.83 MHz Megasonic of Interest to Wafer Cleaning. Ultrason. Sonochem. 2014, 21, 1496–1503
- 20 Komaba, K., Goto, H., 2019. Micro-Bubble Sonic-Electrochemical Preparation of Polyaniline. ECS Trans. 92, 57.
- 21 Maoming FAN, Daniel TAO, Rick HONAKER, Zhenfu LUO, Nanobubble generation and its application in froth flotation (part I): nanobubble generation and its effects on properties of microbubble and millimeter scale bubble solutions, Mining Science and Technology (China), Volume 20, Issue 1, 2010, Pages 1-19, [https://doi.org/10.1016/S1674-5264\(09\)60154-X](https://doi.org/10.1016/S1674-5264(09)60154-X).
- 22 P. Pattekari, Z. Zheng, X. Zhan g T. Levchenko, V. Torchilin, Y. Lvov, Top-down and bottom-up approaches in production of aqueous nanocolloids of low solubility drug paclitaxel PhysChemChem Phys. 13 (19), (2011) 9014-9019
- 23 P. Pattekari, Z. Zheng, X. Zhang T. Levchenko, V. Torchilin, Y. Lvov, Top-down and bottom-up approaches in production of aqueous nanocolloids of low solubility drug paclitaxel PhysChemChem Phys. 13 (19), (2011) 9014-9019
- 24 Parmar, Rajeev; Majumder, Subrata Kumar (2013). *Microbubble generation and microbubble-aided transport process₃₇ intensification—A state-of-the-art report.*

Chemical Engineering and Processing: Process Intensification, 64(), 79–97. doi:10.1016/j.cep.2012.12.002

- 25 Rameshkumar, C., Senthilkumar, G., Subalakshmi, R., RisaGogoi.: Generation and characterization of nanobubbles by ionization method for wastewatertreatment”wastewater and Water Treatment, 164,98-101 2019.
- 26 Rameshkumar, C., Senthilkumar, G., Subalakshmi, R.: Purification of tap water to Drinking water: Nanobubbles Technology;”wastewater and Water Treatment, 233, 11-18 2021.
- 27 SabeeraHaris, XiaobinQiu, Harald Klammler, Mohamed M.A. Mohamed, DOI
- 28 The use of micro-nano bubbles in groundwater remediation: A comprehensive review
- 29 VijayendranRaghavendran, Joseph P. Webb, Michaël L. Cartron, Vicki Springthorpe, Tony R. Larson,Michael Hines, Hamza Mohammed, William B. Zimmerman, Robert K. Poole and Jeffrey Green1 A microbubble-sparged yeast propagation–fermentation process for bioethanol production *Biotechnology for Biofuels* 2020) 13:104
- 30 Wu, T. Y.; Guo, N.; Teh, C. Y.; Hay, J. X. W. *Theory and Fundamentals of Ultrasound. Advances in Ultrasound Technology for Environmental Remediation*; Springer: Netherlands, Dordrecht, 2013; pp 5–12.
- 31 Xu, Q., Nakajima, M., Ichikawa, S., Nakamura, N., Shiina, T., 2008. A comparative study of microbubble generation by mechanical agitation and sonication. *Innovative Food Science and Emerging Technologies* 9, 489–494.