

DESIGN AND FABRICATION OF WASTE WATER TREATMENT PLANT USING HYDRODYNAMIC CAVITATION PRINICIPLE

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering / Technology degree in B.E Mechanical Engineering

By

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**DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Kiran Raj H (38150051), Kumaran R (38150056) who carried out the project entitled "Design and Fabrication of Waste Water Treatment Plant Using Hydrodynamic Cavitation Principle" under our supervision from Dec '21 to Mar '22.

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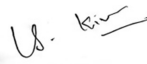
DECLARATION

We KIRAN RAJ H (38150051), KUMARN R (38150051) hereby declare that the Project Report entitled Design and Fabrication of Waste Water Treatment Plant Using Hydrodynamic Cavitation Principle, done by us under the guidance of Dr.J.Jayaprabakar Associate of Mechanical Engineering and Sathyabama Institute of Science and Technology, Jeppiaar Nagar, Chennai-600 119 is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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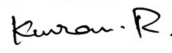
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ABSTRACT

Contamination of water is a serious concern to both human and environment. Textile industries are responsible for one of the major environmental pollution problems in the world. Textile industries discharge colour dyed wastewater into the natural resources. There are several methods for treatment of wastewater, the most common being bleaching. Bleaching makes use of disinfection properties of certain chemicals. We here in this project use a simpler method by using the phenomenon of hydrodynamic cavitation. Unlike bleaching, the hydrodynamic cavitation does not use any chemical for disinfection. Here, venturi section is used as the cavitation device and a submergible pump is used to pump the water at high pressure to the venturi. Methylene blue dye, which is a common constituent of textile wastewater is degraded using the hydrodynamic cavitation principle. The whole process has very low running cost and has simple equipment. Thus, the use of hydrodynamic cavitation for water treatment is very economical, simple to use and eco-friendly.

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LIST OF THE SYMBOLS AND ABBREVIATION USED

H_2O_2

Hydrogen peroxide

CO_2

Carbon dioxide

Cu

Copper

Zn

Zinc

OH

Hydroxyl ion

CHAPTER 1

INTRODUCTION

Clean water has always been an important part of human life. The water that is used for many purposes need to be clean from pathogens and other chemical impurities. There have been several studies in the field of effective and cost-efficient way of cleaning water.

1.1 IMPURITIES IN THE WATER

Water has several impurities present in it either as suspension or as substances in its natural state. Chemicals that are present in the water can change its characteristics. These chemicals can change the pH value of the water which could cause hardness or dissolved oxygen to be present in water. The impurities present in the water are classified below.

1.1.1 *Industrial Effluents*

Industrial wastewater has several impurities present in it. Different industries have different contaminants in their wastewater.

Petroleum industries has oil, benzene, nitrogen, petroleum products in its wastewater. Fossil fuel power plants discharge significant levels of lead, mercury, cadmium, arsenic and nitrogen compounds. Food processing industries expel coliform bacteria, oil, grease, organic nitrogen and ammonia. Iron and steel industries use cooling water which leaves with ammonia, cyanide, benzene, cyanide, phenols etc. Paper and pulp industries generate chloroform, dioxins, furans, phenols, etc. Textile industries expel oil, grease, sulphide, phenols and chromium.

1.1.2 Textile Wastewater

The effluents discharged from the textile factories are a mixture of dyes, metals and other pollutants. Some of the factories expel the effluents without much treatment to natural water bodies as shown in the pictures below.



Figure 1.1: Coloured dyes in textile effluents

The dye effluents are high in colour, pH, suspended solids, chemical oxygen demand, biochemical oxygen demand, salts etc. The textile dyes significantly comprise the aesthetic quality of water bodies, increase biochemical and chemical oxygen demand (BOD and COD), impair photosynthesis, inhibit plant growth, enter the food chain and cause bioaccumulation. The colour in the water bodies due to textile dye prevent the penetration of the light through the water which leads to a reduction in photosynthesis. Some textile dyes are also toxic and carcinogenic.

The picture below shows the harmful effects these chemicals can have on human and the environment.

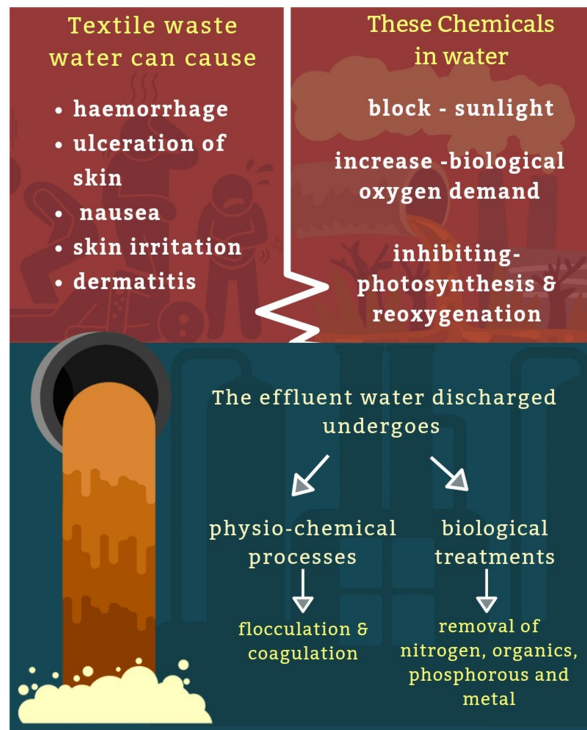


Figure 1.2: Harmful effects of textile wastewater for human and environment and general treatment methods.

1.1.3 Dissolved Gases

Some number of gases is entrapped the water. The main gases present in the dissolved form are oxygen, nitrogen, carbon dioxide and small number of inert gases. Theses dissolved gases are a direct indication of the biological activity in the water. Many micro-organisms feed on this dissolved gas for its survival.

Oxygen is dissolved in the water directly from atmosphere or by photosynthetic activities. Rainwater and decomposition of the organic matter and respiration of aquatic animals and plants are major reasons for presence of dissolved CO_2 in water. These gases are not much harmful and hence most of the treatment methods don't filter it out. The dissolved gases are boon in disguise for cavitation principle as the dissolved gases are responsible for bubble formation during cavitation.

1.1.4 Inorganic Compounds

Inorganic compounds are common in the water. Ions of sodium, calcium, iron, magnesium, chloride, sulphate, nitrate, silicates, borates and bicarbonates. Inorganic pollutants found in water are caused by human activities like mining, industry or fertilizer used in agriculture. Some of these inorganic pollutants have negative health effect for humans and animals. Human health problems like abnormal growth, diabetics, obesity, cancer are consequences of consuming water with high inorganic compounds. However, some of these inorganic materials are very much needed for human survival.

1.1.5 Microorganisms and Bacteria

Bacteria such as Shigella, E. Coli and viruses such as Norwalk virus and rotaviruses may be found in the water. These microorganisms can cause symptoms such as nausea, vomiting, stomach aches, and diarrhoea. Infectious microorganisms may be contaminated by human or animal waste. It can also enter the water from the farms, livestock operations etc.

1.2 WATER TREATMENT METHODS

1.2.2 Filtration

In this method water flows through a filter and impurities present in the water is collected from the water to the filter. The concentration of particulate matter, including suspended particles, parasites, bacteria, algae, viruses, as well as other undesirable chemical and biological contaminants is lowered by significant amount. Filtration is difficult for high sediment water. Lack of taste or odour is a common problem for filtration done in drinking water. A filter consists of various layer like sand, charcoal, gravel etc. As water passes through each layer different impurities are filtered out. There are various types filtration techniques.

1.2.3 Activated Carbon

Activated carbon granules is based on charcoal. The chemical impurities are trapped by adsorption.

1.2.4 Reverse Osmosis

Reverse osmosis is forcing contaminated water through a membrane at relatively high pressure. So, water passes through the membrane leaving behind the contaminants. The contaminants are removed some water which is eventually removed out as wastewater.

1.2.5 Ion Exchange

Ion exchange filters contain zeolite beads containing sodium ions. The hard water which contains magnesium, calcium compounds split apart on encountering the filter into magnesium and calcium ions. The zeolite in filter attracts these ions and release sodium ions which makes water relatively softer.

1.2.6 Distillation

This is a very simple technique to kill all bacteria in water. The water is boiled in one container and then the vapour is collected and condensed in another contained

Toxic heavy metals are left behind without evaporating and the virus, bacteria in the water is also killed due to the high temperature.

1.2..6 Chlorination

Chlorination is one of the most common methods of wastewater treatment. Chlorine is known to be effective in destroying a variety of bacteria, viruses, protozoa etc. the application of the chlorine to wastewater results in the formation of by- products. Chlorination has several benefits which include disinfection, controlling odour, scum and grease removal, ammonia removal. Use of chlorine or chloramine is considered as the most cost-efficient method of water disinfection.

1.2.7 Cavitation

Cavitation is the phenomenon of formation of bubbles in the water due to drastic reduction the pressure of the water. Cavitation itself being an unwanted phenomenon in hydraulic machinery can be used to our advantage on proper usage.

There are several physical and chemical changes that occur during cavitation. The thermal changes can be used to harvest energy from the cavitation. While chemical changes can be used to increase the rate of reactions of some equations without use of catalyst. The below figure shows the thermal, chemical, and mechanical changes thar are accompanied by cavitation.

The first group consists of parameters such as the size and shape of the cavitation inducer and the flow chamber which determine the structural characteristics of the reactor. The second group consists of parameters which characterize the liquid medium in general: viscosity, density, surface tension and the dissolved gas contents. The third group includes the technological process parameters like the processing time (the number of times which the medium passes through the cavitation region) and the interdependence between temperature and pressure of the process.

1.2.8 Chlorination

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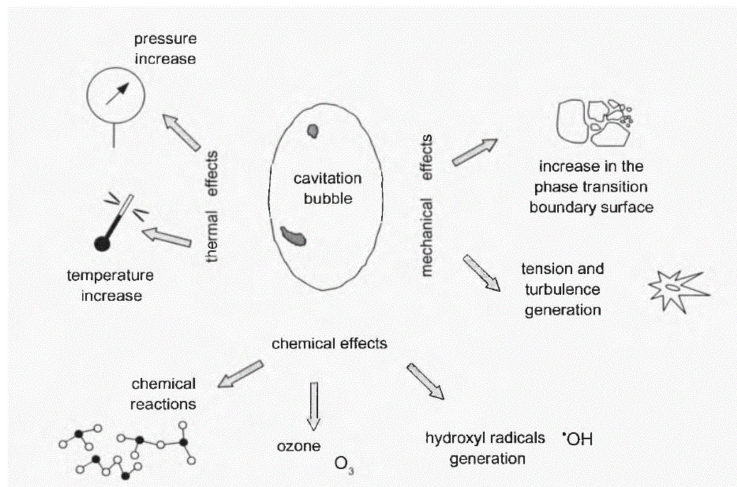


Figure 1.3: Physical and chemical effects produced during cavitation.

There are three main factors that specify the formation of the hydrodynamic cavitation field and the effectiveness of the cavitation process is detailed in the figure below

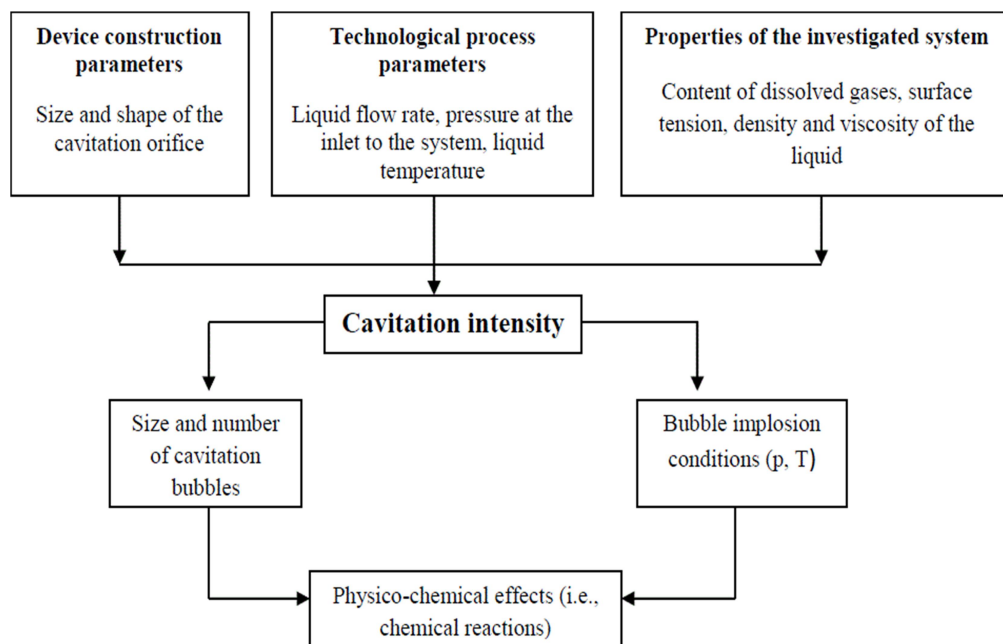


Figure 1.4: Main factors influencing the intensity of the cavitation process.

1.3 TYPES OF CAVITATION

1.3.2 *Hydrodynamic Cavitation*

When water flows through a pipe whose diameter is reduced suddenly, then by Bernoulli's principle then pressure energy is reduced to kinetic energy and hence there is a subsequent drop in pressure. If this pressure is reduced below the vapour pressure for the temperature, then the water molecule is phase changed to vapour bubble.

When the water flows out of the venturi throat then the diameter of the pipe increases and hence the water recovers the pressure and hence the bubble collapses. Collapsing of the bubble is by imploding of the bubble to a point and then exploding, this causes shock wave. This phenomenon is responsible for destruction of bacteria in the water. Due to the cavitation phenomenon, the water molecule splits into the H and OH ions. The OH ions react with each other to form H_2O_2 molecule. H_2O_2 being a very powerful oxidiser can degrade the pathogens in the water.

1.3.3 *Acoustic Cavitation*

Acoustic cavitation uses the help of the high intensity ultrasonic waves to create ripple effect and hence forms mechanical vibrations and this causes negative pressure. This negative pressure causes the formation of bubble. The nuclei bubble absorbs a lot of ultrasonic energy. As the bubble enlarges and bursts a lot of energy is expelled. This bubble formation and explosion causes the acoustic cavitation.

1.4 CAVITATION DEVICES

There are several devices which can be used to produce cavitation based on geometry. Some of these devices are discussed below.

1.4.2 *Venturi*

Venturi is a device that can be fitted in the pipe itself. The device has a construction of two zones namely pressure reducing zone and second is the pressure recovery zone. The pressure reducing zone is an area of venturi where the diameter of the venturi reduces drastically. This is the region where the pressure of the water reduces dramatically, which subsequently leads to formation of bubbles. The other zone, i.e.

pressure recovery zone is the region where the diameter of the venturi increases gradually. When water passes through this region then the pressure of the water increases and hence the bursting of the bubbles. The venturi construction is simple due to relatively easy geometry than other cavitation devices.

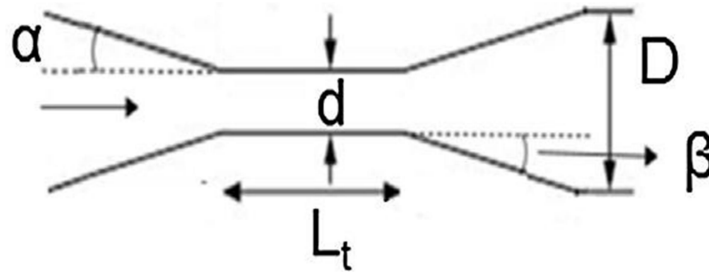


Figure 1.5: Venturi tube

1.4.3 Orifice Plates

Orifice is a hydraulic device which has an obstruction in the flow of pipe. Usually orifice plate is used in the obstruction of flow of pipe. The geometry of orifice usually changes depending on the occasion and the circumstances. Generally, 5 to 6 plates are used in line with small holes of circular pattern around the plate as shown in the figure.

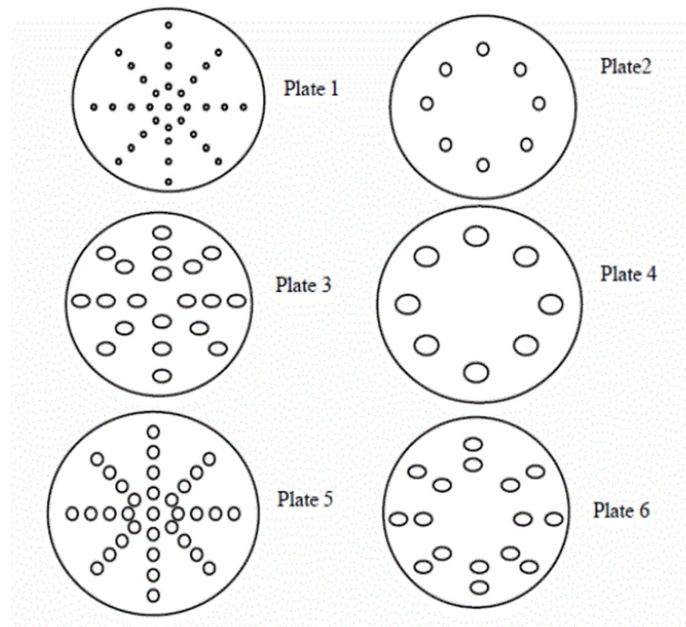


Figure 1.6: Orifice Plates

The hole geometry is changed in each plate both in diameter and position of the holes. The plates are kept inline in a cylindrical tube as shown in the figure below.

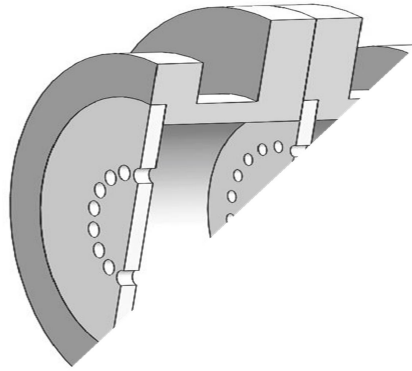


Figure 1.7: Orifice plates arranged inline.

Water when it enters the orifice is restricted by the orifice plates and only the water flows through the holes hence the pressure is lowered. The subsequent orifice plates further help in reducing the pressure. The lowering of the pressure helps in building of the bubbles. The expansion and bursting of the bubbles take place when the water flows out of the orifice plate. This method is very efficient in reducing pressure. But the complex geometry is always a hindrance.

1.4.4 Hydrodynamic Cavitation Reactor

Hydrodynamic cavitation reactor is a device with a stator and rotor assembly. A chamber is selected with pores inside it as stator and a rotor of cylindrical assembly. When the rotor rotates at high speed the water in the chamber undergoes vortex flow around the stator surface due to centrifugal force. The pores in the surface of the stator accommodates small amount of water at negative pressure. This results in the production of bubble around the stator surface resulting in cavitation. The major use of this reactor is in the industries where wastewater is treated through the Hydrodynamic cavitation. The specialised chamber is been constructed in industries where the efficiency can be increased and could overcome the design constraints of the conventional devices. The schematic pictures of hydrodynamic cavitation reactor is shown in the figures below.

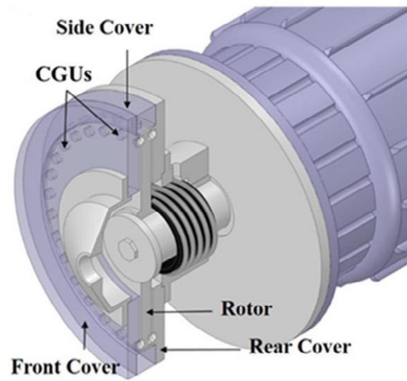


Figure 1.8: Schematic representation of structure of hydrodynamic cavitation reactor.

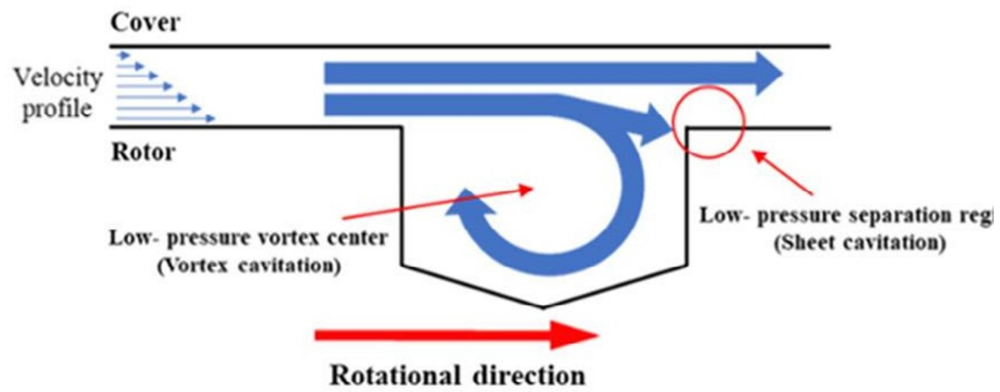


Figure 1.9: Schematic representation of mechanism of hydrodynamic cavitation reactor.



Figure 1.9: Methylene blue dye mixed with water.

1.5 METHYLENE BLUE

Methylene blue is a cationic dye regularly used in the textile industries. It is commonly used in biological staining, colouring wool, paper etc. This dye is used in various applications due to its colour reaction. The effluents released from the textile industries have significant concentrations of methylene blue dye in it. The accumulation of methylene blue in wastewater has adverse health effects when released in natural bodies. Difficulties in breathing, vomiting, eye burns, diarrhea and nausea are common symptoms upon consumption of untreated water with higher concentrations of the dye.

Several physicochemical and biological processes have been carried out like membrane filtration, photocatalytic degradation, biological treatment, adsorption etc. Methylene blue dye mixed in water is shown in the picture below.

1.6 NEED OF THE PROJECT

- a) To design venturi for effective cavitation process.
- b) To use the venturi to treat methylene blue dyed water sample

CHAPTER 2

LITERATURE REVIEW

MANDAR P. BADVE, PARAG R. GOGATE, ANIRUDDHA B. PANDIT, LEVENTE CSOKA

Hydrodynamic cavitation is used in delignification of wheat straw for paper manufacturing. The device used for cavitation is hydrodynamic cavitation reactor with stator and rotor assembly. The wheat straw is cut in small pieces and pre-treated in alkaline solution. Then the wheat straw is passed to the reactor. Cavitation occurs in the reactor and hence formation of hydroxyl radical which help in the delignification of the wheat straw. Hydrodynamic cavitation treatment of wheat straw for the production of paper or paper board takes less treatment time, less energy consumption compared to other conventional techniques and operation at near ambient conditions.

S. ARROJO, Y. BENITO, A. MARTINEZ TARIFA

The physical and chemical conditions generated by cavitation bubbles can be used to destroy microorganisms and disinfect wastewater. The effect of different cavitation chamber designs and diverse operational parameters on the inactivation rate of *Escherichia coli* have been studied and used to understand the mechanisms involved in cell disruption. The effect of discharge pressure was analysed as that increasing the discharge pressure promotes larger and faster pressure recoveries, and therefore increases the violence of bubble collapse. Nevertheless, it also causes a higher minimum pressure hindering bubble growth and decreasing the number of cavitation events.

P. S. KUMAR AND A. B. PANDIT

Hydrodynamic cavitation is modelled using venturi and high-speed homogenizer. Several parameters like bubble cluster dynamics, cavitation number, turbulence modelling is researched. Degradation of potassium iodide was also done using high-speed homogenizer. Effect of inlet pressure in venturi was analysed that at high inlet

pressures, near the venturi throat, the pressure is far higher than the threshold pressure for the onset of cavitation and the flow rate has to be sufficiently increased for the throat pressure to fall below it. Hence, for increasing the flow rate, one must reduce the pressure in the downstream Side of the venturi, keeping the inlet pressure constant. This naturally leads to a larger permanent pressure drop. Effect of downstream pressure was also found out to be as the pressure drop increases or the downstream pressure decreases, the intensity of cavitation also decreases.

DINDAR E

In this paper there are many studies related to hydrodynamic cavitation and the use of associated processes in water and effluent treatment technologies. The factors affecting the hydrodynamic cavitation is discussed along with the economic aspects of this method with traditional methods.

Y. BENITO, S. ARROJO, G. HAUKE & P. VIDAL

This paper focuses using hydrodynamic cavitation as a low-cost advanced oxidation process for wastewater treatment. Venturi is used as cavitation device for a closed loop setup. The flow is also analysed using FLUENT software. Pressure for different divergence angle is measured using the software and the it is compared to find a new venturi design.

L. MEZULEA, S. TSYFANSKY, V. YAKUSHEVICH, T. JUHNA

Hydrodynamic cavitation system is used to study the water disinfection on Escherichia coli bacteria. A sample of the E. coli bacteria was cultured and was subjected to hydrodynamic cavitation reactor. The reactor consists of a rotating disk which is rotated by a motor. The plunger disk pushes the water up and down also by rotating at high speeds creating turbulent flow and cavitation in the liquid layer between the surface of the disk and the plate. Up to 20% of the bacteria cells were made from respiring to non- respiring bacteria by running the sample for just 5 minutes by giving energy input of 0.49 W/cm^3

MINGDA LI, ADRIEN BUSSONNIÈRE, MATTHEW BRONSON, ZHENGHE XU, QINGXIA LIU

The geometry of venturi tube in generation of microbubbles was studied. A 3D printed

venturi is used to study geometry. The parameters studied were Inlet angle, Throat length, Throat diameter, Outlet angle and Diameter ratio was changed, and reading was taken. Further cavitation inception, loss coefficient, bubble generation, was studied.

POOJA THANEKAR AND PARAG GOGATE

The present work overviews the degradation of different pollutants, such as pharmaceuticals, pesticide, phenolic derivatives and dyes, as well as the treatment of real industrial effluents using hybrid methods based on HC viz. HC/H₂O₂, HC/Ozone, HC/Fenton, HC/Ultraviolet.

Irradiations (UV), and HC coupled with biological oxidation. The selection of optimum operating parameters, such as inlet pressure, solution temperature, initial pH and initial pollutant concentration have been discussed in order to maximize the process intensification benefits. Moreover, hybrid methods based on HC has been demonstrated to show good synergism as compared to individual treatment approach. Overall, high energy efficient wastewater treatment can be achieved using a combined treatment approach based on HC under optimized conditions.

VALENTINA INNOCENZI, MARINA PRISCIANDARO, FRANCESCO VEGLIÒ

Degradation of tetramethyl ammonium hydroxide (TMAH) was carried out by hydrodynamic cavitation process. The investigation factors were solution of pH (3 – 20) and time (5 -20 min). The experiments have been carried out at a fixed temperature of 20°C and a pressure of 4 bar. The optimal performance (around 44%) of process for degradation of tetramethyl ammonium hydroxide was observed at pH = 3 after 20 minutes.

YUEQUN TAO, JUN CAI, BIN LIU, XIULAN HUAI, ZHIXIONG GUO

In this paper, different aspects of hydrodynamic cavitation used for wastewater treatment have been reviewed. Theoretical studies, including the basic mechanism of pollutant degradation, the modelling of pressure distribution in cavitation reactor and the bubble dynamics models coupled with chemical reactions, are evaluated. Experimental setups of various design of reactors and operation parameters are compared under the desired conditions for degrading specific kinds of pollutants in wastewater. The effort directions for both theoretical and experimental investigations have been provided based on this review.

CHAPTER 3

METHODOLOGY

The designing of the venturi is done by using the SolidWorks software. The design is simulated in SolidWorks flow simulation and flow parameters such as inlet pressure, flow velocity, temperature distribution is analysed. The geometrical parameters like cavitation number, divergence angle and location of bubble cluster formation in the venturi is calculated from the data obtained through simulation. The material for the fabrication of the venturi is selected as brass as it has high anti-corrosion properties. The brass workpiece is then machined to make venturi of calculated dimensions. Then the pump is selected as 40W submersible pump. The pump has discharge equal to 3200 LPH. At last whole setup is then arranged. Water sample for treatment is prepared by adding 5 drops of methylene blue dye to 10 litre waters.

The various steps followed for the mini project is shown as a flow chart in the figure below

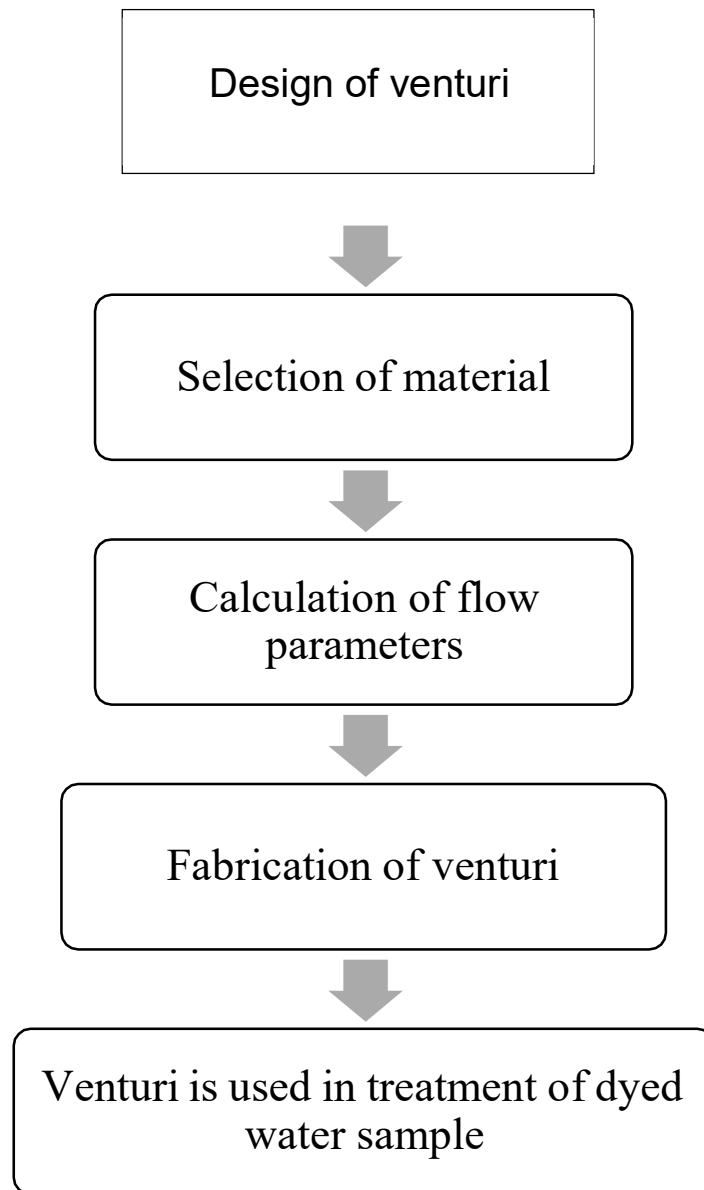


Figure 3.1: Flow chart of various step used in this project

CHAPTER 4

DESIGN CALCULATION

4.1 CAVITATION NUMBER

Cavitation number is a dimensionless number which is used to characterise the cavitation phenomenon.

$$C_v = \frac{P_2 - P_v}{\frac{1}{2} \rho V_{th}^2}$$

Where

P_v – vapour pressure at the operating temperature.

P_2 – pressure at exit of venturi

ρ – liquid density

V_{th} – velocity of liquid at venturi throat.

From simulation,

$$P_2 = 107375 \text{ Pa}$$

$$P_v = 3166 \text{ Pa}$$

$$V_{th} = 12.56 \text{ m/s}$$

$$\rho = 1000 \text{ kg/m}^3$$

So, By calculation, Cavitation number

$$C_v = 1.3$$

4.2 DIVERGENCE ANGLE

Divergence angle or pressure recovery angle must be chosen carefully while designing the venturi. At a first glance one might think that bigger angles lead to faster decelerations and therefore faster pressure recovery, but the situation is rather the opposite. Abrupt divergences produce boundary layer detachment and recirculations. As a result of this effect the pressure losses increase. On the other hand, if the divergence angle is too small, the residence time of fluid particles in the Venturi will increase.

Geometrical characteristic (α):

$$\alpha = \frac{d_p - d_v}{2L}$$

where d_p = diameter of pipe = 12.5 mm

d_v = diameter of venturi throat = 2.5 mm

L = length of the expansion section of the venturi = 90 mm

Therefore $\alpha = 0.006$

Angle of pressure recovery zone = $\tan^{-1}(\alpha) = 3.7^\circ$

4.3 DIAMETER OF VENTURI TUBE AT THE LOCATION OF CAVITY CLUSTER:

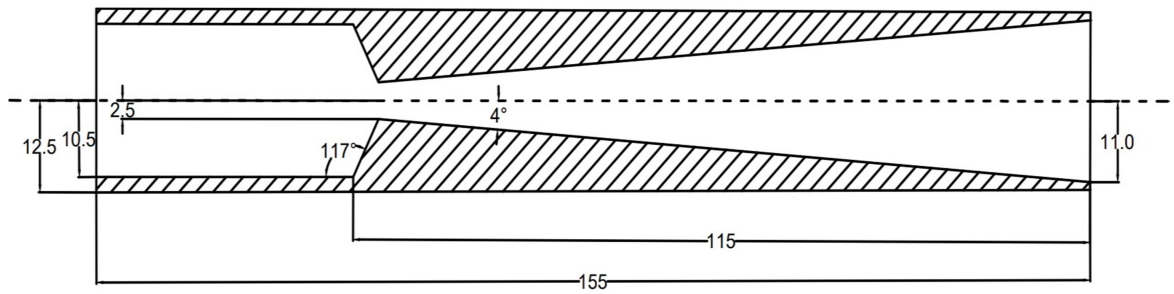
$$d_x = (2\alpha) + d_v$$

$$d_x = (2 * 0.006) + 2.5$$

$$d_x = 2.512 \text{ mm}$$

based on these calculations, venturi was designed.

The 2D diagram of venturi drawn using AutoCAD and 3D model simulated in SolidWorks are shown below.



ALL DIMENSIONS ARE IN MM

Figure 4.1: venturi design 2D drawing

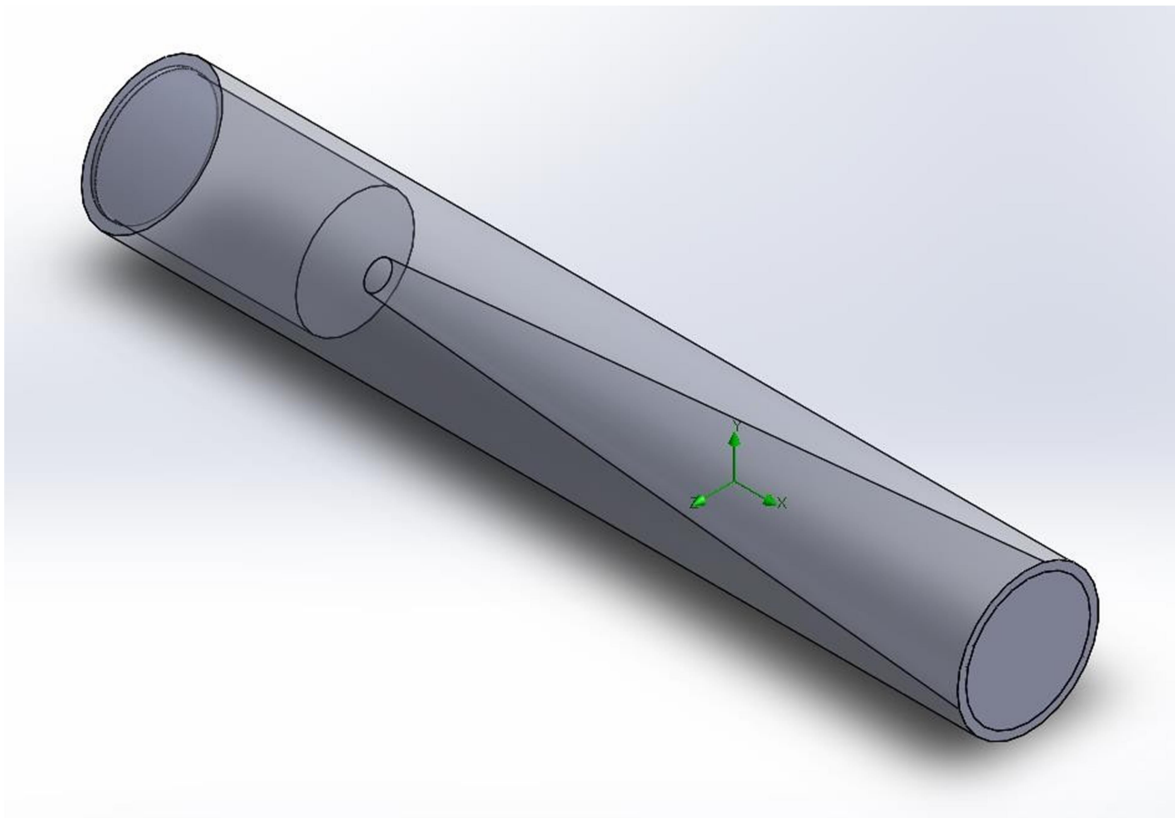


Figure 4.2: Venturi design 3D model

CHAPTER 5

FABRICATION

5.1 DESIGN AND ANALYSIS OF THE VENTURI

The design and analysis of the venturi was done using SolidWorks software. The part model of the venturi was analysed under the flow simulation. Parameters like throat diameter, inlet discharge, convergence angle and pressure recovery zone angle were changed, and the minimum pressure was measured.

The venturi designed in this project is made of Brass which is an alloy of copper and zinc in a composition of 66%(Cu) and 34%(Zn). The melting point of brass can be up to 940°C and the density can vary from 8.4 to 8.73 g/cm³.

Brass has high machinability and high resistance to corrosion which makes it an ideal material for the fabrication and design industry specially in conditions which are prone to corrosion. Along with the copper content in it which has anti-microbial properties has a significant factor for water treatment.

It is also used widely in flammable or explosive conditions like fittings and tools as brass is not affected by the sparks or heat generated in those conditions. In addition to this the workability and malleability of Brass is also very high thus making it an ideal material for multiple uses. The only downside with brass is that after some time it will tarnish resulting in a blackish coating, but it will rarely affect the functionality for the material

Since the project material must have high rust and corrosion resistance, this ruled out iron and its related materials. The other factors were cost, availability and easy machinability, which left us with four more materials which were Copper, Bronze, Aluminium and Brass. Aluminium being a soft material was rejected due to the possibility of being easily susceptible to wearing and damaging the venturi design in case of harsh or an accident which would inadeptly cause the failure of the project goal.

Copper when compared with Brass and Bronze was also both expensive and is harder to machine around. The Brass and bronze are both suitable materials with Brass being a little more ductile and malleable. Even though bronze has a higher corrosion resistance to salt water it is not as significant for the conditions for which our project cater to. Finally, Brass was decided for its better workability along with its reduced cost compared with bronze making it ideal for our project.

The venturi section which was fabricated in brass and the picture is shown below.



Figure 5.1: Fabricated picture of venturi (front view)



Figure 5.2: Fabricated venturi design (Cross-sectional view)

5.2 FABRICATION OF VENTURI

Brass cylindrical raw piece was purchased for fabrication of the venturi. Floor mounted engine lathe was used for machining the raw workpiece. The tool used for machining brass workpiece is tungsten carbide tool. Facing operation was done to get the venturi in the required length. Then, turning operation was done with cutting speed of 150 rpm. Compound rest is adjusted in such a way for boring short steep taper at the beginning of the venturi. Then angle for the steep taper boring is 120° . Then the end side of the venturi is fixed in the chuck. The compound rest is then tuned at 4° for gradual deep taper boring till the throat of the venturi. Surface finishing is done by running at small speed and providing small depth of cut. Outer surface of the venturi is turned for good surface finish. Chamfering is done on the ends to avoid sharp cuts.

5.3 SELECTION OF PUMP

The pump used in this project is a FEDUS 40-watt submersible pump with a discharge of 3200 LPH. The pump for this project was decided after analysing the results and the factors critical for simulating the phenomenon of Hydrodynamic cavitation. The factors mainly being high water discharge which in our design needed to be at least 28 LPM for cavitation to occur satisfactorily, the other factor while deciding the pump was power consumption as it is a necessity when choosing almost any electrical device which can increase the working cost of the project.



Figure 5.3: FEDUS 40-watt submersible pump

The After thorough consideration of the above-mentioned factors a submersible pump with a water output of 3200 LPH with a rating of 40-watt was decided. The pump being submersible has a higher water discharge compared to almost any of other types of conventional pumps in the market at its price and specifications. The pump is also light in weight and compact for better portability. The pumps body is made of plastic and is also easy to run which is pivotal factor in water treatment as it would require regular maintenance.

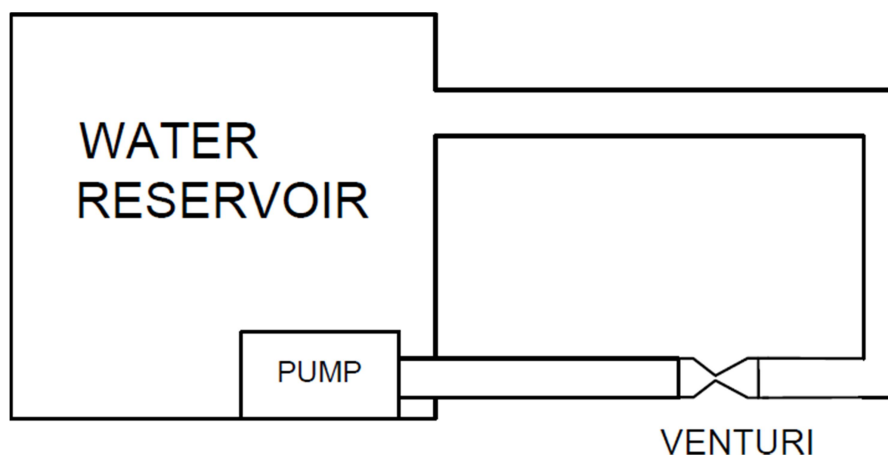


Figure 5.4: Layout of whole setup used in wastewater treatment plant

RESULTS AND DISCUSSION

The set-up consists of the venturi for cavitation, pump and water reservoirs. The submersible pump is immersed inside the water reservoir which when switched on pumps the water out to around 3200 LPH to get maximum pressure at inlet.



The water from the submersible pump is pumped at high pressure towards the venturi. The water passes through the venturi hole facilitating which results in sudden decrease and increase in the pressure of the fluid which facilitate the phenomenon of hydrodynamic cavitation. During cavitation the OH radicals are formed which along with sudden increase in temperature in a microscopic level due to the bubbles bursting which helps in treating the contaminated water. 5 drops of Methylene blue dye is added

to 10 litres of water. The water after undergoing cavitation is then stored in the water reservoir. Making the whole system a closed loop system. The whole setup is run for 15 minutes, so that cavitation occurs effectively in the water. Due to sudden formation and explosion of small bubbles in the water the microorganisms, bacteria and viruses are too destroyed due to this method. The dye degradation for various time is shown in the figures below.

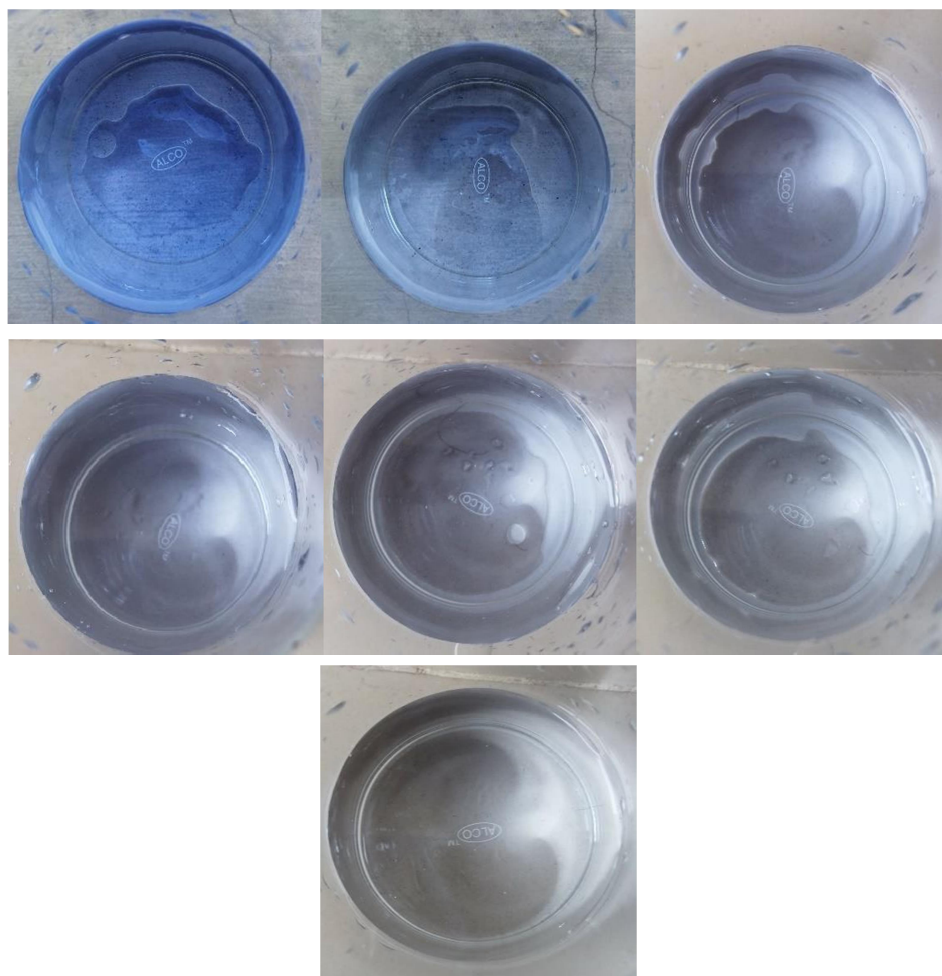
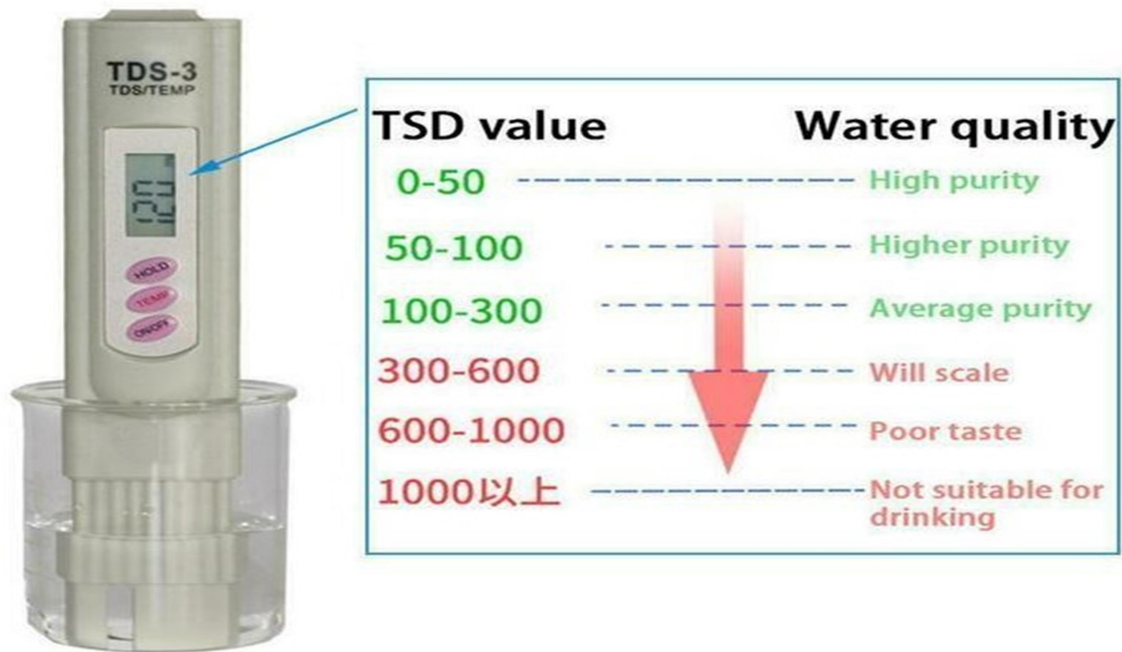


Figure 6.2: Photos of water sample taken at different time intervals.

The above figure shows the images taken of the water from the exit of venturi at the beginning, after 1 minute, 3-minute, 5-minute, 8-minute, 10-minute and 20-minute respectively. From the above images it is clearly evident that the methylene blue dye has been degraded significantly after undergoing the cavitation process.

6.2 RESULTS FROM TDS METER



As shown in the above figure the same value for drinking water lies between the range 0-100 ppm.

Testing the water after treatment the value acquired is

TDS Value before purification-370 ppm

TDS Value after purification-280 ppm

We infer from the results that this system is used for the purification of wastewater into water consumables for floor cleaning and dishwashing purpose

CHAPTER 7

CONCLUSION

The hydrodynamic cavitation method can be used effectively for wastewater treatment of dyes from the textile effluents. Thus, we conclude that Hydrodynamic cavitation is an effective and economical solution for water treatment containing organic and non-organic substances, thus providing a viable solution for environmental protection in the present scenario.

This method can be used as a pre-treatment process or can be used in combination with other methods at small scale usages. But at industrial level this method alone can work very efficiently.

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