IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

# Advanced Method for Treatment of Wastewater.

**[1]Pravin R. Gulave, [2]Prof. N. M. Garad**

[1,2]Chemical Engineering Department, Pravara Polytechnic College Loni, Tal-Rahata, Dist-Ahmednagar.

*Abstract:* Cavitation is the process in which formation and collapse of micro bubbles. In this case, we had used venturi as a cavitating device for the treatment of waste water so that it is called as Hydrodynamic cavitation. In this process, the intensity of collapsing bubbles depends on the operating parameter such as pressure. This process can be carried out at maintaining the different pressure and checking the waste water characteristics such as biological oxygen demand, Chemical oxygen demand, Total organic carbon, Colour and Biodegradability Index etc. The results shows when we controlling the geometric as well as operating condition of the system then we getting the required physical and chemical changes. In this study we are comparing the conventional waste water treatment method and hydrodynamic cavitation method, these results show the Hydrodynamic cavitation method is effective and energy efficient as compared to conventional method.

**Keywords:** BI, BOD, COD, Distillery Wastewater, Hydrodynamic Cavitation, Inlet Pressure, TOC.

## 1. Introduction

Waste water is defined as domestic waste water or combination of domestic and industrial waste water with or without rain runoff. In India near about 14000 million liters per day waste water is produced. The treatment capacity of municipal waste is near about 12000 million liters per day. The industries produce large amount of waste water, it becomes near about 14000 million liters per day. So, from the above waste water treatment capacities and production of waste water, only 60 percent of waste water is treated. The small-scale industries are not interested to develop its own effluent treatment plant due to financial problem.

The waste water produced from these small industrial plants are directly sent in to the natural stream causes serious water pollution problem. If the similar rate is going on than it is expected in 2050, the water generated from the city centres may be greater than 150,000 million liters per day. Also, in the case of rural areas it may be more than 50,000 million litters per day. It is very dangerous condition but our waste water management plans do not discuss with the increasing rate of waste water production.

The studies of CPCB (Central pollution control board) shows, in India there are 275 sewage treatment plants but out of these only 240 plants are in working condition. From the above condition we understand only 30 percent treatment capacity is available for the present sewage production [7].

The typical compositions of waste water are as shown in table 1.1

Table 1.1 Typical compositions of waste water: -

| Constituent | Concentration | | |
|---|---|---|---|
| | Strong | Medium | Weak |
| Totalsolid (mg/L) | 1200 | 720 | 350 |
| Dissolved Solid (mg/L) | 850 | 500 | 250 |
| Suspended solid (mg/L) | 350 | 220 | 100 |
| Settle able solid (mg/L) | 20 | 10 | 5 |
| Biochemical oxygen demand (mg/L) | 400 | 220 | 110 |
| Total organic carbon (mg/L) | 290 | 160 | 80 |
| Chemical oxygen demand (mg/L) | 1000 | 500 | 250 |
| Nitrogen (Total N) (mg/L) | 85 | 40 | 20 |
| Organic (mg/L) | 35 | 15 | 8 |
| Free ammonia (mg/L) | 50 | 25 | 12 |
| Nitrites (mg/L) | 0 | 0 | 0 |
| Nitrates (mg/L) | 0 | 0 | 0 |
| Phosphorus (mg/L) | 15 | 8 | 4 |

| | | | |
|---|---|---|---|
| Organic (mg/L) | 5 | 3 | 1 |
| Inorganic (mg/L) | 10 | 5 | 3 |
| Chlorides (mg/L) | 100 | 50 | 30 |
| Alkalinity as ($CaCO_3$) (mg/L) | 200 | 100 | 50 |
| Grease (mg/L) | 150 | 100 | 50 |

The conventional advanced treatments are capable for reducing the pollutant concentration to favoured level as well as some method are useful for getting the reusable water. The two main factors affecting this method are not cost effective. Out of these methods, many methods are the separative methods such as membrane separation, adsorption and ion exchange.

Due to this condition this method is not capable to degrade the pollutants in to the acceptable end products i.e. $CO_2$, $H_2o$ etc. From these disadvantages, these processes are not performing satisfactory hence we require developing the advanced treatment. These methods are not used as pre-treatment option with the conventional treatment of secondary method for the purpose of increasing efficiency. Due to the above all limitation these processes are very costly. Therefore, we want to discuss new technique for the purpose of overcoming these drawbacks. In this paper we are discussing about the hydrodynamic cavitation method. This method can be used individually or in combination with the other conventional processes. This method is also applied to large scale operation. It is cost effective as well as higher efficient as compared to other processes.

**2. Hydrodynamic cavitation**

This process can be carried out by using venturi meter, orifice meter or valve. According to the Bernoulli's principle, if liquid is flowing through the orifice plate than velocity is increased. If we are providing throttling valve before the caviting device than the throttling is possible. Due to throttling, the pressure at vena contracta point becomes decreases and its decreases below the entering pressure i.e. vapor pressure. Due to the above condition millions of cavities are generated. After the vena contracta the pressure recovery of liquid is started at the downstream side. In the downstream side process of cavity collapse occurs. In this process some amount of energy is lost so that permanent pressure drop occurs. The intensity of cavity collapse depends upon the amount of pressure drop. The value of pressure drop depends on the size of the caviting device as well as flow rate of the liquid. If these two parameters are maintained than we are getting the desired result. During the collapse of bubble, the temperature is increases very rapidly.

**2.2. Experimental Setup**

The Process flow diagram of Hydrodynamic cavitation is as shown in fig. The fallowing system consist of one tank, it's having capacity 12 liters, after this one positive displacement pump. This system is also consisting of three control valves $V_1$, $V_2$ and $V_3$. It also consists of venturi as a caviting device and it can be fitted by using flanges. This device is fitted in to the main line in between two pressure gauges. The system also consists of bypass line for the purpose to control the flow rate of main pipe line.

The bottom end of the tank is connected to the pump. In this system flow rate of the liquid is controlled through the adjustment of piston stroke and also valve is provided for the same purpose. The main function of valve those are provided in to the main line is to control the main line flow. We are taking one precaution here i.e. the main line and bypass line are well inserted in to the tank for the purpose to avoid any air contact. The venturi can be manufactured by using the material of brass. In this tank we was take 5 liter sample [10].

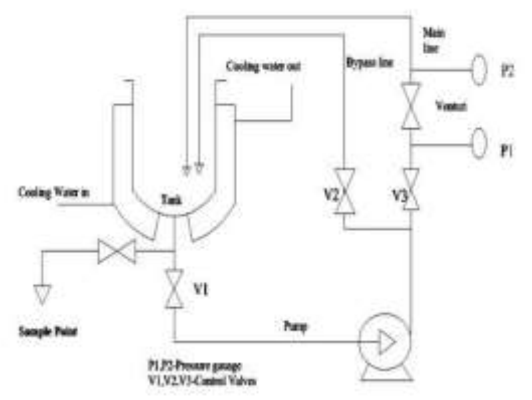



Figure 2.2: Hydrodynamic Cavitation reactor set-up

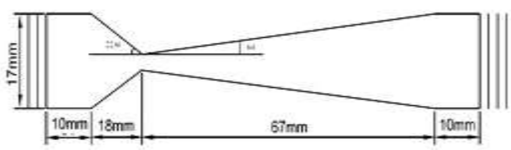



Figure 2.3: Circular Venturi

**3. Wastewater (WW)**

After the treatment of conventional, the waste water sample was collected in to the 20 liter carboys and it is sent in to the laboratory for the purpose to finding the waste water characteristics i.e. physical and chemical composition of waste water. The result is shown in table 3.1.

Table 3.1: Wastewater Characteristics

| Parameters | Value |
|---|---|
| pH | 7.65 |
| Color | Brown |
| COD(mg/L) | 36000 |
| BOD(mg/L) | 6000 |
| TOC(mg/L) | 11,000 |
| Total solids(mg/L) | 32000 |
| Total suspended solids(mg/L) | 1700 |
| $BOD_5$:COD ratio | 0.166 |

**3.2. The Waste Water Preparation**

In this case we are stored the waste water sample at 3-6ºC and after that it attain the room temperature before the experiments. After that this sample is used in Hydrodynamic cavitation.

**3.3. Chemicals**

We are used chemicals for the COD examination is potassium dichromate, Mercuric Sulphate, Sulphuric acid as well as ferroin indicator. For the BOD examination we are used Magnesium sulphate, Iodide, Sodium hydroxide, Sulphuric acid, Starch indicator, Calcium chloride, Ferric chloride. For the purpose of TOC examination, we are used phosphoric acid, Sodium carbonate and bicarbonate. The distilled water is used for the different purposes as well as tap water is used for the strength of ww during cavitation pre-treatment process its pH becomes 7.1, BODND, COD-ND [2].

**3.4. Biodegradability**

Biodegradability Index (BI) is nothing but the ratio of BOD5: COD. It is a parameter for calculating biodegradability (willing to biological treatment) of a wastewater. This parameter is generally referred as biodegradability index (BI) with mention to fitness of wastewater for biological treatment [16]. The BI can be calculated after the hydrodynamic cavitation pre-treatment and compared with that of the unprocessed WW.

**3.5. Hydrodynamic Cavitation**

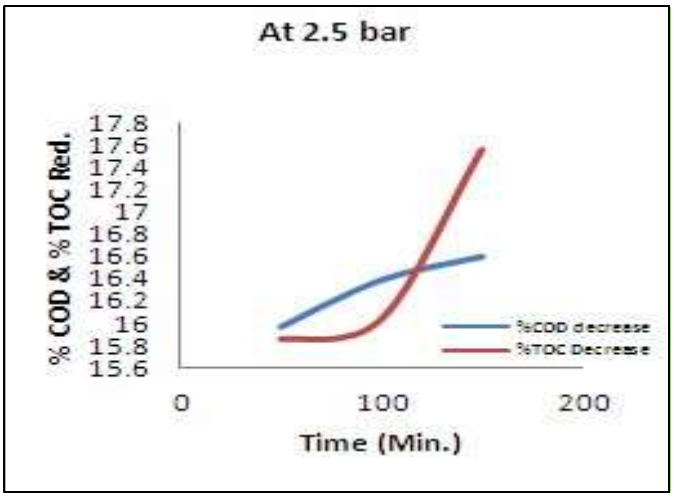
By using Hydrodynamic cavitation, we are treated 5 litter sample of waste water. In this system we are used circular venturi for producing cavitation. The process flow diagram of this system is shown in fig 2.2. This experiment was carried out at different inlet pressure i.e. low as well as high and also different dilution of the waste water with for maintaining the time range of 50 to 150 minutes. In this process we are removing the sample at particular time period through the sample point. After that this sample is kept for the purpose of centrifuged and analysis the ww characteristics such as pH, BOD, COD, TOC and color as per the standard procedure [10].

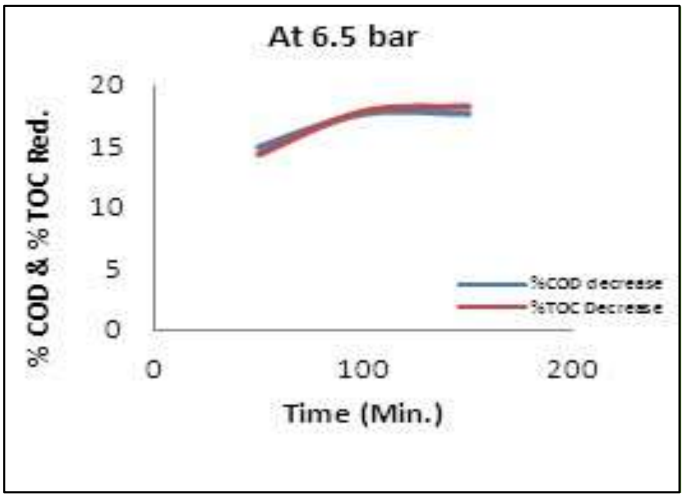
**4. Results & Discussions**

**4.1 Result of Inlet Pressure on WW**

For the COD and TOC reduction, we are carried out this experiment at two different inlet pressure i.e. 2.5 bar and 6.5 bar. We are considering on the average basis, the inlet COD of waste water becomes 33000 mg/L. After the particular time interval, the sample can be removed from the reactor and calculate the COD and TOC.

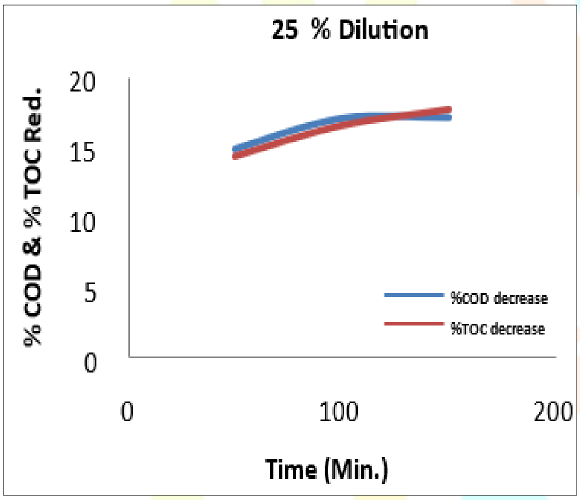
The result is shown in following graph. From the result we getting idea, if pressure is increases than there is no any significant reduction of COD and TOC. At 2.5 bar, the reduction of COD becomes 17 percent and reduction of TOC becomes 18 percent. From this observation, the considerable reduction of COD and TOC occurs at initial 50 min, so that the 50 min is the optimum treatment time for the reduction of COD and TOC. The result obtained at 6.5 bar shows no any additional reduction of COD and TOC. From this observation the next experiment we are carried out at 2.5 bar condition.

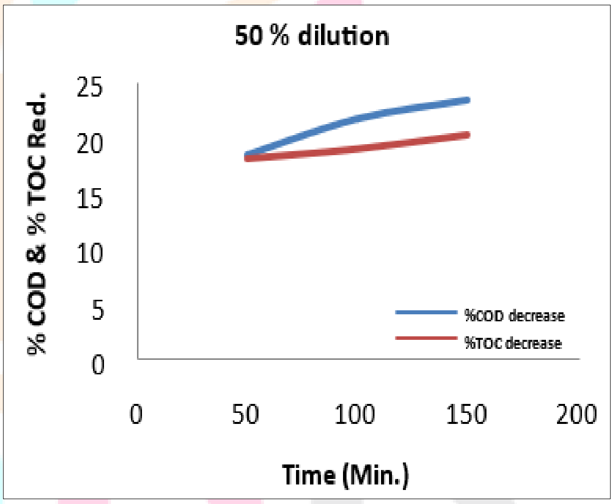



**4.2 Result of Dilution on WW: -**

In this case we are used tap water for the purpose of dilution. The original waste water is having 33000 mg/L COD. This waste water is diluted at 25 percent to 50 percent concentration. After that this waste water is treated in Hydrodynamic reactor at significant operating pressure. At particular time interval, the sample can be removed from the reactor and calculating the COD and TOC of the waste water. The result is shown in the following graph 4.2. From this result we getting idea there is no any significant reduction of COD and TOC. Here the reduction percentage is slightly greater at 50 percent dilution but the reduction of COD as well as TOC at 25 to 50 percent dilution is lower than the unprocessed waste water. This result is against to the literature report, in that increasing dilution increases the reduction of waste water characteristics. But at the present case it is not true.

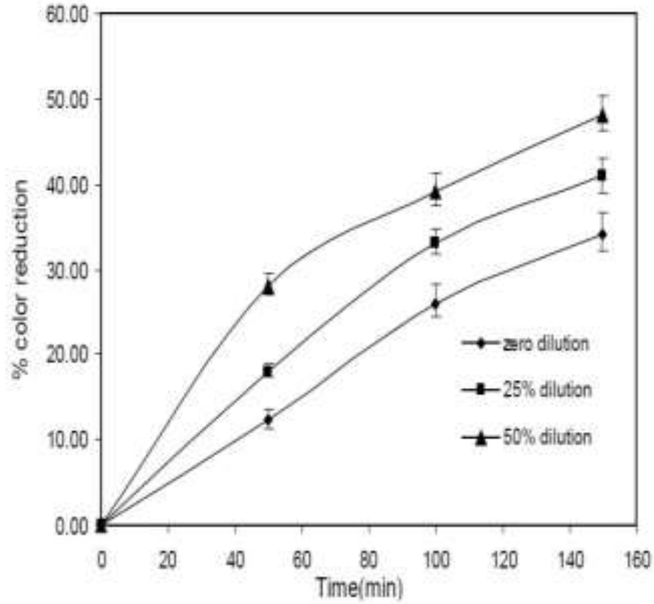



**5.3 Color Reduction of WW: -**

Due to the presence of a composite biopolymer called melanoidins causes the dark brown color of the wastewater. This melanoidins are not only Maillard reaction products but also due to the caramel colorants. These are produced during the processing (concentration, evaporation) of sugarcane juice at higher temperatures in sugar industries as also during the distillation of sugarcane molasses [5] for the recovery of absolute alcohol. The hydrodynamic cavitation treatment is not only reducing the COD and TOC but also abridged the total color concentration of WW. The treatment of hydrodynamic cavitation at most favourable inlet pressure (2.5 bar) specifies that a maximum 35% color might be removed. The color reduction sketch is shown in graph 4.3

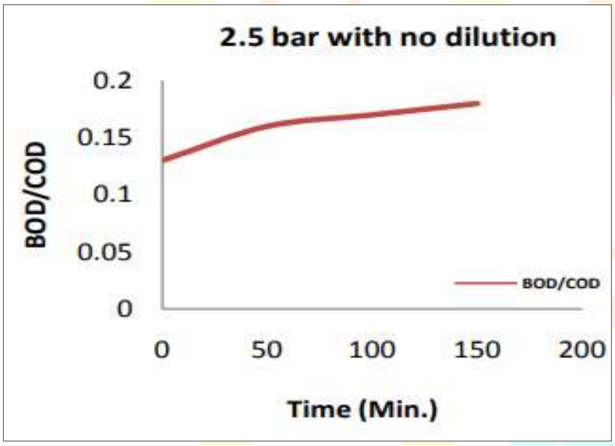
The results shown in the graph 4.3specify that HC not only abridged COD and TOC but also decreasing the color content of the wastewater. For unmixed wastewater a maximum 33% color diminution is obtained, in the case of 25% to 50% concentration of diluted wastewater, a maximum color diminution occurs up to 40% to 47% respectively.

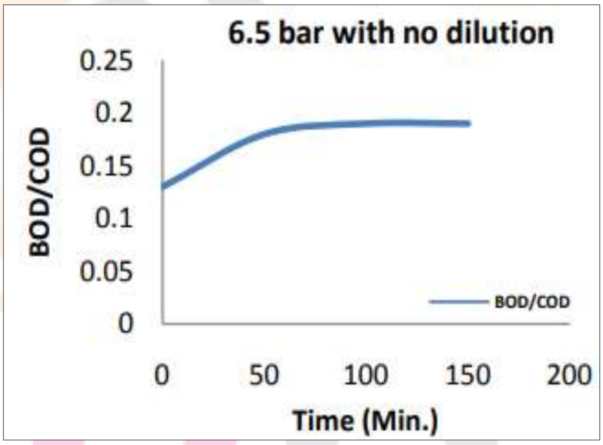


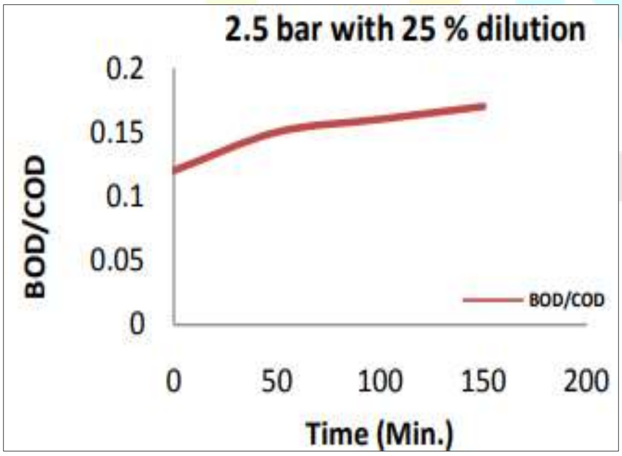

### 4.4 Biodegradability of WW

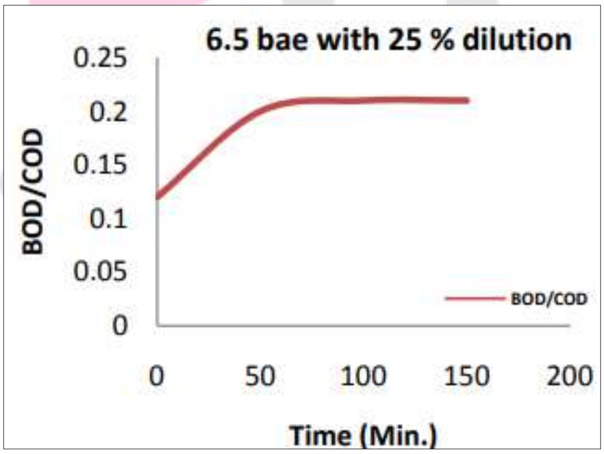
The biodegradability index is nothing but the ratio of $BOD_5$ to COD. The minimum ratio of BOD to COD is becomes 0.3 to 0.4, so it is ideal for any waste water good biodegradability. If the ratio is greater than or equal to 0.3, so it is advantageous for coupling with the aerobic treatment. If the ratio is equal or greater than the 0.4, so it is suitable for anaerobic treatment. Due to the treatment of hydrodynamic cavitation, the BI is increases. The value of BOD and BI is as shown in the graph4.4. From the result we get idea when we increasing the pressure, the BI are also increases. From the above study, the 2.5 bar pressure is significant for the reduction of COD and TOC as well as the 6.5 bar pressure is significant for the increasing BI.

Therefore, we can say that hydrodynamic cavitation is capable for decreasing the toxicity of waste water. Due to the pre-treatment of hydrodynamic cavitation increases the biodegradability of waste water. Hence this treatment can be effectively and efficiently carried out for the composite waste water.



**6. Conclusion: -**

The hydrodynamic cavitation treatment can be efficiently and effectively carried out for increasing the biodegradability of composite wastewater with decreasing toxicity i.e lesser COD, TOC as well as color. From the above result we have to conclude two things, the 2.5 bar pressure is effective and suitable for the toxicity reduction. The second thing is that when pressure is increases than biodegradability of waste water increases from the result of 6.5 bar pressure. From the above observation and result we can conclude that this experiment shows that the hydrodynamic cavitation is the more efficient and effective for the degradation of pollutants present in the waste water. This method can be applied individually or in combination with the other conventional treatment so this is another advantage of this treatment.

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