HYDRODYNAMIC CAVITATION - A TOOL FOR DISINFECTION

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INTRODUCTION

For the shortage of traditional water treatment methods, a variety of new water treatment methods have been proposed. Hydrodynamic cavitation, as an economic and efficient water treatment method without disinfection by-products, has attracted widespread attention. As hydrodynamic cavitation occurs, the local pressure inside the fluid drops sharply, which is below the saturated vapour pressure of this state, and the gas dissolves in the water to be separated out, which leads to the generation and growth of cavitation bubbles. With the fluid flowing, the local pressure returns to normal state, and then the cavitation bubbles collapse, this results in a rapid rise in temperature and pressure. Compared with the other two cavitation modes, hydrodynamic cavitation has higher efficiency and lower energy consumption. Besides, it is easier to realize in practical application and has absolute advantages in economy. Therefore, hydrodynamic cavitation is more suitable for water treatment industry and has been widely studied worldwide. With the rapid development of modern industry, hydrodynamic cavitation has been applied in water treatment. Besides, it has been proved that it is feasible for water treatments. As an efficient and energy-saving water treatment method, hydrodynamic cavitation has been investigated widely, and project mainly includes the effects of hydrodynamic cavitation water treatment, cavitation mechanism

OBJECTIVES

To study the percentage of disinfection of water using different orifice and valve configurations. Parameters- Zooplanktons population, Colour, COD

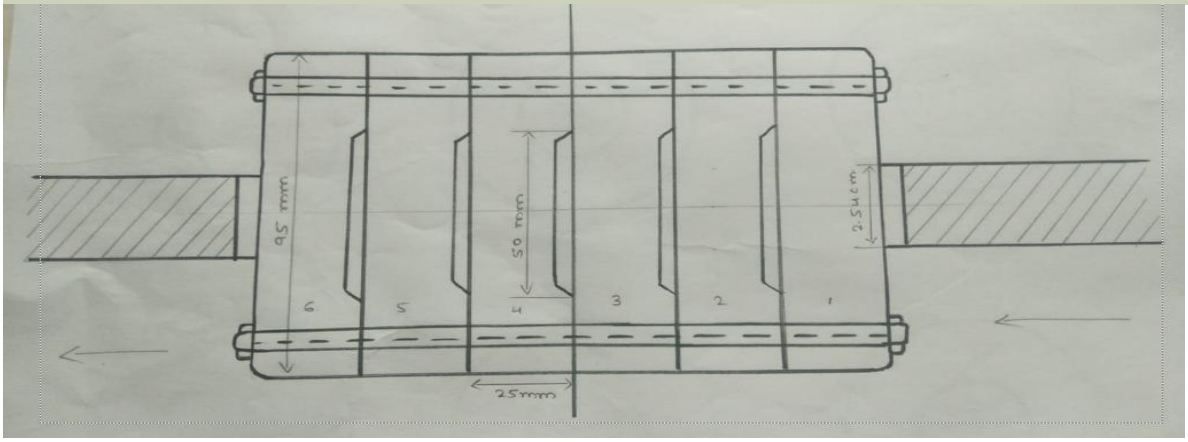
Materials and Methodology

- Pump (1/2 hp)
- Acrylic sheet (25 mm thickness and 5 mm thickness)
- Pressure gauge
- Plankton net
- Valves
- PVC pipes

- Water sample(local pond)

1. Setup consists of a feed tank and a collection tank of 0.12 m^2 area. A centrifugal pump of 0.5 hp connected to feed tank. Pipe diameter of 1 inch is used. Pressure gauges are fitted across pipes to measure the pressure at different positions valves are connected to pipes.
2. Orifice of different configurations are used and fitted across pipe for creating hydrodynamic cavitation.

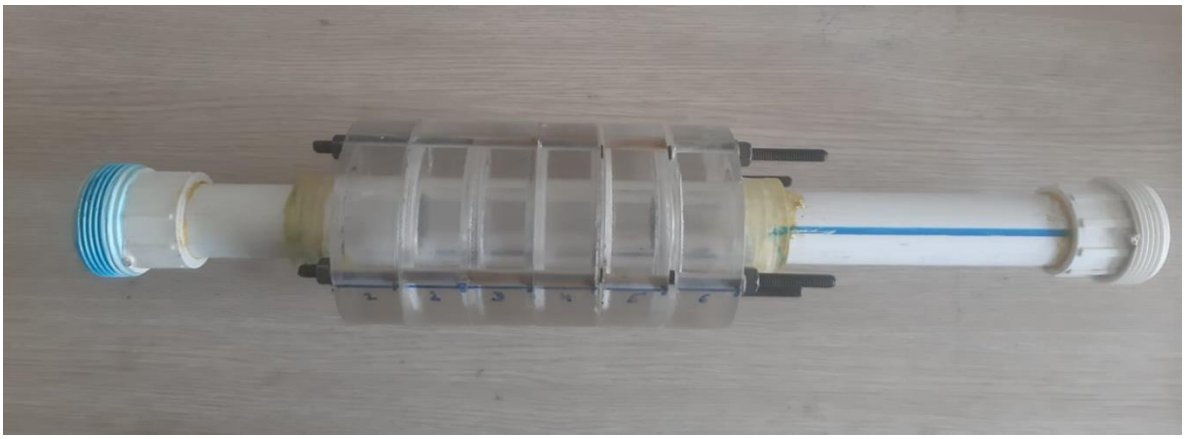
- Assembly of two flange



- Total assembly
- Orifice plates are fabricated for different configurations.

  Beta ratio is given by

  (β) = dc / Pipe ID



Where the calculated bore is equal to 2 x typical orifice hole size (dc = 2d).Standard orifice plates are sized to a beta ratios from 0.1 to 0.75. In a standard schedule pipe, the conditioning Orifice Plate beta ratios equal 0.4 and 0.65. The most obvious difference between standard orifice plates and the conditioning orifice plates is the number of holes in the plate.

Wkt, β=0.4 - 0.65

By taking β = 0.4 and pipe I.D = 1 inch

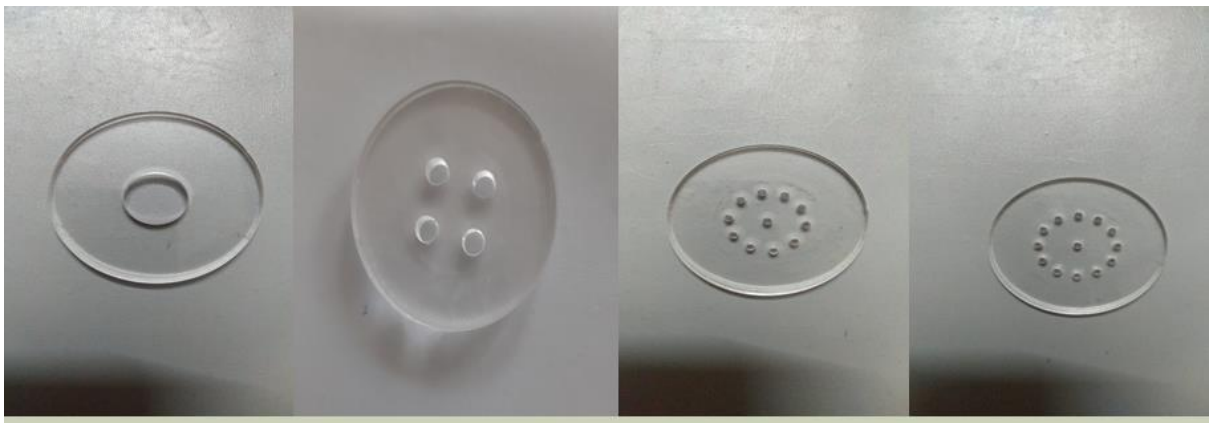
For single hole 1 hole of 1.5 cm diameter

For multiple holes

4 holes of 5 mm dia each

11 holes of 2 mm dia each

13 holes of 2mm dia each



- The Conditioning Orifice Plates have four holes that are placed in a circular pattern, leaving a metal section of the plate in the centre of the pipe. This causes the flow to condition itself as it is forced through the holes, thereby removing the requirement for a flow conditioner. Because of this phenomenon,

conditioning orifice plates provide superior performance in short straight pipe run and tight fit applications.

- Overall setup

6. Water rich in zooplanktons is collected and stored in (Feed tank). This will be evaluated for the abundance of live organisms. Feed water is made to pass through the pump building the pressure and made to pass through orifice. Hydrodynamic cavitation occurs downstream treated water is collected if required several cycles can be tried for better performance.
7. The procedure is repeated for different orifice plates with keeping valve 100% open.
8. Treated water is collected and checked for different parameters:
   i. Analysis of zooplankton population

- Lackey's Drop Count Method:

$$\text{Organisms per litre (N)} = \frac{R * A_t * 10^3}{A_s * S * V}$$

Where R-Number of organisms counted per sample

A_t –Area of coverslip, mm2

A_s- Area of one strip, mm2

S-Number of strips counted

V- Volume of sample under the coverslip, ml

$$\text{Concentration Factor, C} = \frac{\text{Volume of original sample (ml)}}{\text{Volume of concentrated sample (ml)}}$$

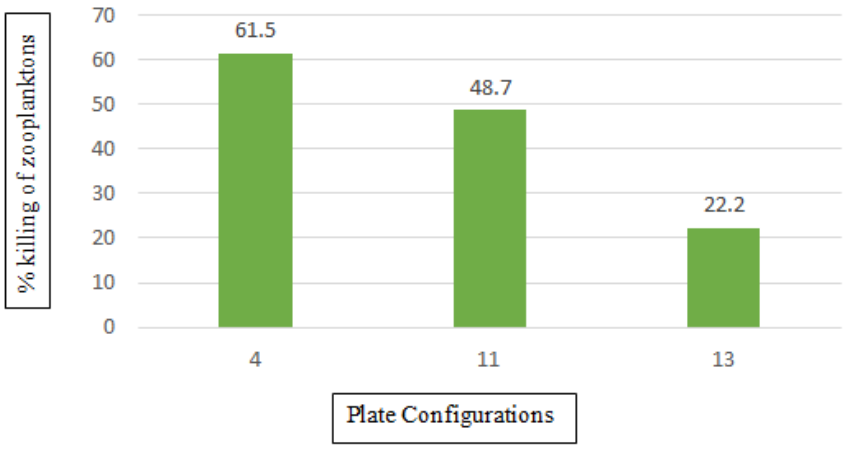
$$\text{Therefore, Total of organisms per litre} = \frac{N}{C}$$

ii. Analysis of COD was done by general laboratory using soxhlet apparatus.
iii. Prominent color change was observed.

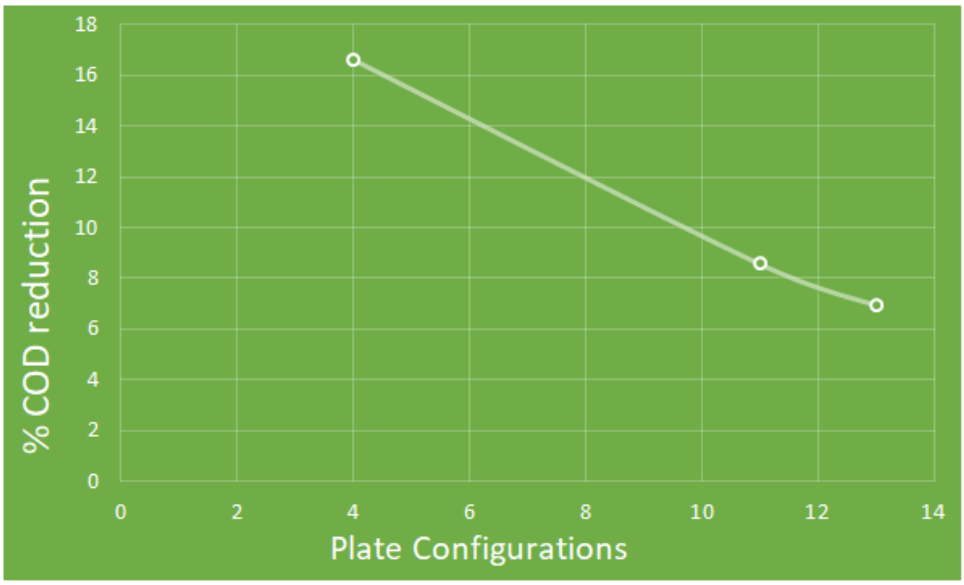
Results & Discussions

Before	After 4 holes plate	Before	After 11 holes plate	Before	After 13 holes plate
8 zooplanktons (5 sub samples)	3 zooplanktons (5 sub samples)	6 Zooplanktons (5 sub samples)	3 zooplanktons (5 sub samples)	9 zooplanktons (5 sub samples)	7 zooplanktons (5 sub samples)
N = 5184/ lt	N = 1994/lt	N = 3888/lt	N = 1994/lt	N = 5832/ lt	N = 4536/lt
For 75 lts 3,88,800	For 75 lts 1,49,550	For 75 lts 2,91,600	For 75 lts 1,49,550	For 75 lts 437400	For 75 lts 340200
	% killing = 61.5		% killing = 48.7		% killing = 22.22

- **Zooplankton Analysis**



- **COD Analysis**



INNOVATION IN THE PROJECT

- Disinfection can be done without the usage of chemicals.
- Non-toxic means of treating water
- One time investment, efficient, less energy consumption.

FUTURE SCOPE

- It can be used for dye removal.
- It can be taken as primary treatment method before membrane separation.
- It can be applied for particle size reduction.
- Its energy can be harnessed for various physical and chemical processes.