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Performance Study on Effect of Inclination & Length of Tube in Tube Settler Module on the Effluent Water Quality

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ABSTRACT: Water is the most valuable substance and most important chemical compound on the Earth. It is very important part of life on Earth. So, it is important to use clean and pollution free water for drinking and other purposes. The water treatment plant plays an important role for supplying and purifying the water to make it safe for consumers. This study is aimed to emphasize the performance of tube settler unit. A pilot scale model of tube settler is prepared and Effect of Inclination, Length & Diameter of tube in tube settler model on the Effluent water Quality is studied. Tube settler are the equipment use for enhancing the settling capacity of settling tank, improve effluent water quality, and decrease operation cost of treatment units. Tube settler use multiple tubes sloped at an angle and adjacent to each other. Which combined to form an increased effective settling area for fast settling of particles. Current study focuses on the study made to understand the Effect of Inclination, Length & Diameter of tubes in tube settler on the effluent quality through a tube settler model. The circular tube of 40mm diameter were used with inclination of 45° & 60° length of tube was varied as 60cm, 70 cm & 80cm.

KEYWORDS: Tube settler, diameter, Inclination, Length, effluent, influent, settling.

I. INTRODUCTION

Water is the most important chemical compound on the earth. It is the only compound found on earth in the liquid state and the only compound found on Earth in all three states solid, gaseous and liquid at the temperatures normally found on the Earth. Water is an important factor for life on earth & hence it is the only essential commodity for life's survival on the planet from among all components present in nature, water is the most subjected to pollution. Sedimentation is a physical treatment process that utilizes to separate suspended solids from water by gravity. This process is widely used in the first stage in surface water treatment to remove causing turbidity particles after coagulation and flocculation. Most of the municipal towns have facilitate with drinking water supply schemes and treatment plants. Due to day by day increase in population, urbanization and industrialization, demand for water supply is increasing. Installation of new treatment plants to meet the increased demand is beyond the reach of most of the local bodies and government as well. Hence ways are to be introduced to increase treatment capacity and to improve the performance of existing water wastewater plants to increase treatment capacity of settling tanks, reduce new installation footprints, improve effluent water quality, accelerate treatment process, save time of treatment and decrease operating costs. Constructed of lightweight PVC, tube settler modules can be easily supported with minimal structures that often incorporate effluent troughs and baffles. Modules are available in a variety of sizes to fit any tank geometry and tube lengths to accommodate a wide range of flows. The work focuses on the study made to understand the effect of length and inclination of tube settler through the Tube settler model study.

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II. LITERATURE REVIEW

AmodGurjar et al., 2017 A pilot scale model of sedimentation tank is prepared & installed for performance measurement. In conventional sedimentation tank the detention time required is 2-4 hrs. In view of increasing demand of water for society, a modification is used in water treatment plant i.e. high rate settling. The detention time is reduced up to 10-15 min. which is very less as compare to conventional sedimentation tank. The setup is design and fabricated with MS sheet and installed at water treatment plant at Nagpur Region. The size and shape of tube for unit is square length of tube is kept as 1 m and is placed at an angle of 60° inclinations with horizontal. The no. of tubes was 6. The area for each tube is 25 cm². shows the cross section of tube shape and size is 5cm breadth and 5 cm depth. The average efficiency of turbidity removal is 70-80% in modified unit as compare to conventional tube settler unit.

KshitijaBalwan et al., 2016 Conducted a pilot scale model and installed at Ichalkaranji municipal water treatment plant the effect of length and inclination of tube settler the flocculated water was used the multiple tubular channels of tube settlers are used at an angle of about 45° to 60° and adjacent to that with the used of this the increased effective settling area the circular tubes were used with inclination of 45 to 60 degree of 45 mm diameter the length of tube varied as 60 cm, 50 cm, & 40 cm the four pvc tubes of 4.5 cm diameter was connected to the bottom of base tank representing the tube settler.

A Faraji et al., 2013 Conducted a pilot scale model and installed at the exbatan wastewater treatment plant the polyvinyl chloride (Pvc) material are used of 20 cm diameter at angle 45° related to horizontal the 60 cm length of tube in both the stages in conventional secondary clarifiers examine the possibility of applying one and two stage inclined tube settlers are used. The results show that in 20 min detention time in the tube the average removal of TSS, BOD, and COD in one stage tube settler pilot plants was 97.5%, 96.3%, and 96.4% respectively while in other conventional secondary sedimentation basin was 98%, 99%, and 98.7% respectively.

Shirley E. Clark et al., 2009 Reviewed the inclined plates/ tube settler in that overlapped plates are used for large settling area and also treated for multiple contaminants in that the flow operated in laminar flow conditions, In this paper the work are carried out by investigating of inclined plate settlers to treatment the runoff in that Reynolds numbers ranged from 7.5 to 50000 in that the used of settlers high removal of particle density achieved over the range of an Reynolds numbers in that the tereekleen device technology in inclined plate the results showed that the Reynolds number tested form the laboratory simulated storm water was capable of removing > 65% of solids are removed with the used of inclined plate settlers.

Cheng He et al., 2009 conducted vortex plate in an clarifiers instead of smooth lamellae in conventional the modelling and laboratory experiments was study by using computational fluid dynamics (CFD) in that crushed walnut shells & glass beads were mimicked by suspended particles the vortex plates are forming an slots of 25 depth and 25 width by attached perpendicular ribs to the plate and the plate placing at an angle 60° to the horizontal and plate parallel to an longitudinal clarifier axis a computational fluid dynamics was applied to clarifiers the result shows that the used of two vortex plate or an two smooth plates the vortex plates removing 8% more particles than the used of smooth plate with the used of vortex plate the particle removal will be more by larger inflow rates and for slower settling particles by up to 26%.

A.G. Bhole et al., 1996 In this paper the suspended solids are removed. By sedimentation in a conventional clarifier. The depth of the conventional clarifier is about 2 to 3.5 meters and the detention time is in the range of 2 to 4 hours. Thus, a lot of time is required in conventional clarifier for the settlement of flocks. The term high rate settlers refer to shallow gravitational settling devices with detention periods of the order of 10 to 20 minutes. The efficiency of high rate settlers is also more than that of conventional clarifier. The present study an attempt is a made to evaluate the relative performance of conventional and modified tube settlers for the four configurations of the tubes, namely circular, square, hexagonal and chevron the tubes were modified by reorienting them and by introducing partitions in the tubes. The tubes were fabricated such that the c/s, area of all the tubes was 25 cm². Therefore, the square tubes have

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5 cm sides, circular tubes have 5.65cm diameter, hexagonal tubes have 3.10 cm each side and chevron tubes have 4.20 cm each side are used. The percentage removal efficiency of the conventional tube settlers varied from 75 to 89% after six hours of observation depending on the turbidity and angle of inclination, whereas the percentage removal efficiency of the modified tube settlers varied from 82 to 97% for identical condition.

III. MATERIAL AND METHODS

The pilot scale model was prepared and conditions are made similar like water treatment plant the model had one closed base tank which was connected to influent water, which was the aerated and coagulated water. The base tank is made by attaching mild steel plates this tank is connected to the bottom of 50 PVC tubes of 4 cm representing the tube settler. The length and inclination of these pipes were adjustable. The direction of flow was kept similar to that of conventional clarifier i.e. upward. The effluent water was collected by small collector basin and finally stored in small collector drum.



Fig (a)- tube settler unit



Fig (b)- tubes arrangement

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Fig (c)- turbid water sample

The turbidity of influent as well as effluent water was measured using Nephelometer. Lengths of tubes were kept as 60cm, 70cm and 80cm, while the inclination was kept as 45° and 60°. Thus, there were different combinations tried.

- Combinations-
1. Diameter 4 cm, Length 80 cm, with inclination of 45° and 60°.
 2. Diameter 4 cm, Length 70 cm, with inclination of 45° and 60°.
 3. Diameter 4 cm, Length 60 cm, with inclination of 45° and 60°.

The turbidity of influent as well as effluent was measured and compared with the turbidity of effluent produced by conventional clarifier.

IV. RESULT AND DISCUSSION

For each combination the turbidity of influent and effluent with and without tube settler were measured. The observations of various combinations are as follows:

1. For Diameter 4 cm, Length 80 cm, with inclination of 45° and 60°

LENGTH OF TUBE	DIAMETER OF TUBE	BETENTION TIME	ANGEL OF INCLINATION	INITIAL TURBIDITY	FINAL TURBIDITY	% TURBIDITY REMOVEL
80 CM	4 CM	45 MIN	45	50 NTU	29 NTU	42%
			60	50 NTU	36 NTU	28%

2. Diameter 4 cm, Length 70 cm, with inclination of 45° and 60°.

LENGTH OF TUBE	DIAMETER OF TUBE	BETENTION TIME	ANGEL OF INCLINATION	INITIAL TURBIDITY	FINAL TURBIDITY	% TURBIDITY REMOVEL
70 CM	4 CM	45 MIN	45	50 NTU	32 NTU	36%
			60	50 NTU	41 NTU	18%

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Fig (d)- turbidity removal (turbid water to clear water)

3. Diameter 4 cm, Length 60 cm, with inclination of 45° and 60°.

LENGTH OF TUBE	DIAMETER OF TUBE	BETENTION TIME	ANGEL OF INCLINATION	INITIAL TURBIDITY	FINAL TURBIDITY	% TURBIDITY REMOVEL
60 CM	4 CM	45 MIN	45	50 NTU	35 NTU	34%
			60	50 NTU	42 NTU	16%

V. CONCLUSIONS

After successful completion of project we come to the following conclusions:

1. Increasing the length of tube settler, results in higher turbidity.
2. Decreasing the inclination of tubes, results in higher turbidity removal.
3. Out of 6 combinations tried, the optimum result was observed for the length 80 cm and inclination 45°.

VI. FUTURE SCOPE

Various shapes of tube are currently available in market and also used to improve capacity as well as performance of clarifier so those shapes should be used in comparison with circular pipes.

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