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Comparative Study on Effect of Variation in Diameter, Inclination, Length & of Tubes in Tube Settler Module on the Water Quality

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Abstract: ***The newly developed settler is an application of the lamella settler, which use inclined parallel tubes in the vertical direction, contrary to the usual horizontal arrangement. In this method, the separated clear water is removed directly by suction from the top end of the inclined tubes. Since each settling tube acts as a small settling tank, the treatment capacity is proportional to the number of settling tubes. Based on the results of the laboratory and on-site experiments, it is shown that the new tube settler system is very effective for the enhancement of settling tank performance. It is also shown from a numerical estimation that the settling tank installed with the new system has extremely high performance compared with the conventional settling tank.***

Current study focusses 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 & 50mm diameter were used with inclination of 45˚ & 60˚ length of tube was varied as 60cm, 70cm & 80cm and the number of tubes is 50.

Keywords: effluent, influent, settling, Tube settler.

I. INTRODUCTION

The water treatment plant plays an important role for supplying and purifying the water to make it safe for users. This study is aimed to know the effect in change in performance of tube settler unit with varying diameter, inclination and length of tubes in tube settler unit. A module of tube settler is prepared and Effect of Inclination, Length & Diameter of tube in tube settler model on the Effluent water Quality is studded. Tube settler are the equipment use for enhancing the settling capacity of settling tank, improve effluent water quality by reducing turbidity of water, 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 partials.

We can use the tube settler concept in new as well as old water treatment plant. And increase the efficiency of the plant in cleaning of water. This will save time and cost of treatment of water.

II. LITERATURE REVIEW

1) *Amod Gurjar 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 15 to 20 minutes. which is very less as compare to old school 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 100 cm and is placed at an angle of 60-degree inclinations with horizontal. The no. of tubes was 6 to 8. The area for each tube is 25 cm^2. shows the cross section of tube shape and size is 5cm breadth and 5 cm depth. The average efficiency of turbidity removal is 70% in modified unit as compare to conventional tube settler unit.
2) *Kshitija Balwan et al., 2016* Conducted a pilot scale model and installed at Ichalkaranji water treatment plant the effect of inclination and length of tube settler the flocculated water was used the multiple tube channels of tube settlers are used at an angle of about 45 to 6o degree 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 of 4.5 cm diameter the length of tube varied as 60 cm, 50 cm,& 40 cm the four poly vinyl chloride tubes of 4.5 cm diameter was connected to the bottom of base tank representing the tube settler.

3) *A Faraji et al., 2013* Conducted a pilot scale model and installed at the exbatan waste-water plant the polyvinyl chloride (poly vinyl chloride) material are used of 20 cm diameter at angle 45˚ related to horizontal the 60 cm length of tube in both the steps 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 tubes the average removal of total suspended solids, Biochemical oxygen demand, and Chemical oxygen demand 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.
4) *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 inclined 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 degree 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%.
5) *Shirley E. Clark et al., 2009* Reviewed the inclined plates/ tube settler in that overlapped plates are used for large settling area In this research the work are carried out by testing of inclined plate settlers to treatment the runoff in that Reynolds numbers ranged from 7.5to 50000 in that the used of settlers high removal of particle density achieved over the range of an Reynolds numbers in that the three keen 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 plates.
6) *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 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 cross-sectional area of all the tubes was 25 cm². Therefore, the square tubes have 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 conditions.

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 50PVC tubes of 4 cm & 5 cm diameter in alternate experiment, 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.
The turbidity of influent as well as effluent water was measured using Nephelometer. Lengths of tubes were kept as 70cm and 80cm, while the inclination was kept as 45^o and 60^o. Thus, there were different combinations tried. Combinations-

A. Diameter 3cm, 4 cm, 5cm Length 80 cm, with inclination of 45^o and 60^o.
B. Diameter 3cm, 4 cm, 5cm Length 70 cm, with inclination of 45^o and 60^o.

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

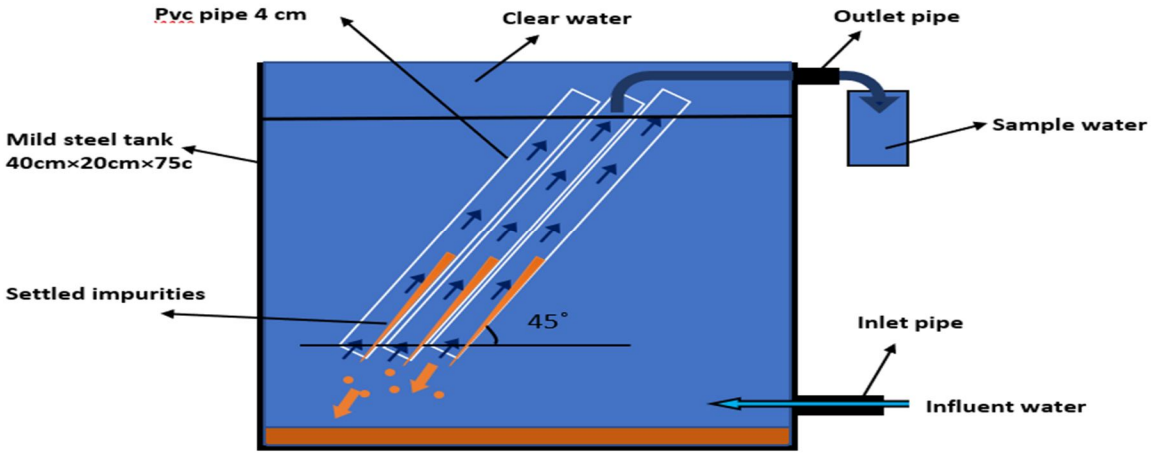

Fig- (a) arrengment of tube settler model

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:

A. Diameter 3cm, 4 cm, 5cm Length 80 cm, with inclination of 45^o and 60^o.

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

B. Diameter 3cm, 4 cm, 5cm Length 70 cm, with inclination of 45^o and 60^o.

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	42 NTU	16%
	5 CM		45	50 NTU	31 NTU	39%
			60	50 NTU	41 NTU	18%

Fig- (b) test for coagulation dose (jar test).

Fig- (c) tube settler model.

Fig- (d) test arrangement of tubes in the tank.

V. CONCLUSIONS

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

1) Increasing the length of tube in tube settler, results in higher turbidity.
2) Increasing the Diameter of tubes in tube settler, results in higher turbidity removal.
3) less the inclination of tubes, results in higher turbidity removal.
4) Out of these combinations tried, the optimum result was observed for the length 80 cm length, 5cm diameter 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.

VII. ACKNOWLEDGEMENT

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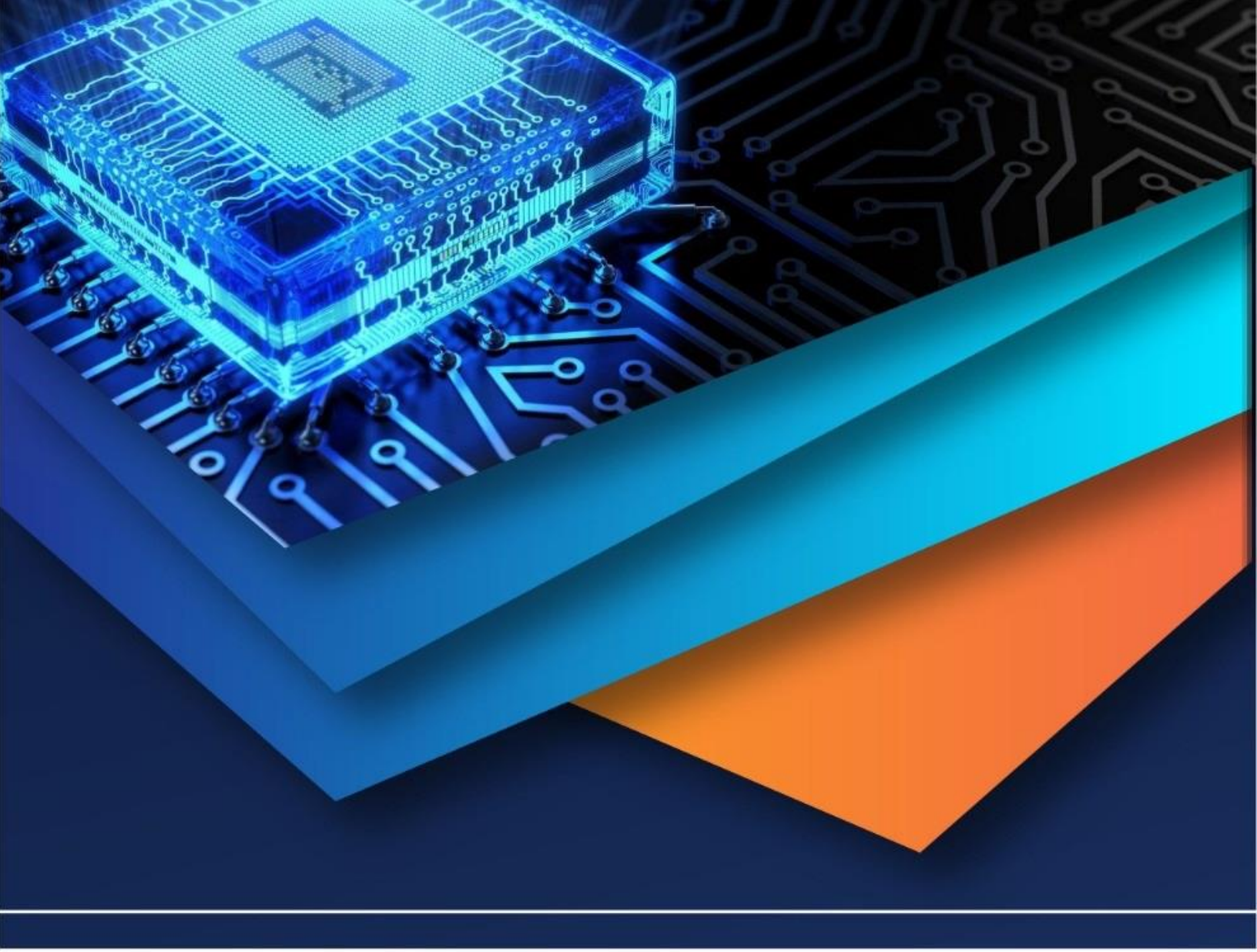

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