Performance Evaluation And Application Of Tube Settlers In Water And Wastewater Treatment

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Abstract- *Water quality is an essential aspect of human health, and household water often contains suspended particles, silt, and other impurities that reduce its clarity and usability. This project focuses on the design, fabrication, and evaluation of a home-scale tube settler, a simple and low-cost sedimentation unit that improves water quality before filtration or use. The tube settler consists of inclined tubes arranged in a small container, which accelerates the settling of suspended solids and reduces turbidity.*

Domestic water samples were collected from sources such as overhead tanks and bore wells, and water quality analysis was performed before and after treatment. Parameters including turbidity, total suspended solids (TSS), pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and odour were measured. The results show that the tube settler effectively reduced turbidity from 18 NTU to 5 NTU and TSS from 42 mg/L to 14 mg/L. Improvements in colour, odour, and overall water clarity were also observed, while chemical parameters remained within safe limits.

The study demonstrates that tube settlers are a practical, space-efficient, and economical method for pre-treatment of household water, enhancing the performance of filtration systems and ensuring safer water for domestic use. This project highlights the potential of small-scale sedimentation systems in improving water quality in homes with minimal cost and maintenance.

I. INTRODUCTION

Water is one of the most essential resources for human survival, domestic use, agriculture, and industry. Ensuring access to clean and safe water is a critical concern, as many sources of domestic water contain suspended particles, silt, clay, and other impurities that affect its clarity and quality. Conventional household water treatment methods such as filtration may not remove fine suspended solids effectively, resulting in cloudy water and potential health risks. With limited space and resources in homes, there is a need for simple, cost-effective, and efficient pre-treatment methods that improve water quality before filtration or use.

A tube settler is a compact sedimentation device that enhances the settling of suspended solids by directing water through multiple inclined tubes. The inclined arrangement increases the effective settling area, reduces the settling distance, and allows fine particles to settle efficiently, making it more space- and cost-efficient than conventional sedimentation tanks. Tube settlers are widely used in industrial and municipal water treatment, and their principles can be applied to small-scale or household water treatment systems.

II. PROBLEM STATEMENT

In many residential areas, household water contains suspended impurities such as dirt, sand, and fine particles, especially when water is supplied from bore wells, overhead tanks, or during the rainy season. Conventional household filtration methods are sometimes not effective in removing fine suspended solids, and installing large treatment systems is not practical due to space and cost limitations.

There is a need for a compact, low-cost, and efficient sedimentation system that can be used at the household level to improve water clarity before filtration or storage. Tube settlers offer a simple solution by enhancing the settling process within a small space. Therefore, this study focuses on the feasibility and application of a small-scale tube settler system for domestic water treatment to improve water quality in homes while minimizing space, cost, and maintenance requirements.

III. OBJECTIVE

- To study the working principle of tube settlers for sedimentation at a household level.
- To design and develop a small-scale tube settler model suitable for home water treatment.
- To evaluate the effectiveness of tube settlers in removing suspended particles from domestic water.

- To compare water clarity before and after using the tube settler system.
- To provide a compact and low-cost solution for improving household water quality.
- To reduce the load on household filtration systems by improving pre-treatment sedimentation.
- To study the feasibility of using tube settlers in limited residential spaces.

IV. PROPOSED METHODOLOGY

The proposed methodology aims to systematically investigate the causes, effects, and mitigation strategies of Water pollution. The study combines field measurements, data analysis, and evaluation of control measures to provide a comprehensive understanding of Water pollution dynamics [2] [8]. The methodology is divided into the following steps:

4.1. Literature Review

Relevant textbooks, research papers, and online resources are studied to understand the working principle, design aspects, and applications of tube settlers, particularly for small-scale and domestic use. [1] [3] [9].

4.2. Design of Home-Scale Tube Settler Model

A compact tube settler model is designed considering space availability in a household. The tubes are arranged in an inclined position (approximately 55°–60°) inside a small container to enhance sedimentation efficiency. [6] [12].

4.3. Selection of Materials

Low-cost and locally available materials such as PVC pipes or plastic tubes, a transparent container, adhesive, and simple fittings are selected to construct the model. [1] [6].

4.4. Collection of Water Samples

Domestic water samples are collected from sources such as overhead tanks, bore wells, or tap water containing visible suspended particles. [3] [7] [10].

4.5. Observation and Data Collection

The collected water is allowed to pass slowly through the tube settler unit. The settling process is observed, and the treated water is collected at the outlet. Visual clarity of water is observed before and after treatment. If possible, simple tests such as turbidity comparison or suspended solids estimation are carried out. [2] [5] [9].

4.6. Result Analysis

The effectiveness of the tube settler is evaluated by comparing the clarity and quality of water before and after treatment. The observed results are analyzed to assess the feasibility and efficiency of the tube settler system for household water treatment.

V. DUST POLLUTION ANALYSIS

The analysis shows that after passing water through the tube settler unit, there is a noticeable reduction in turbidity and suspended solids. This indicates that tube settlers are effective as a **pre-treatment unit** for domestic water treatment. Sample water was collected from a **domestic source (overhead tank / bore well)**. [8] [11].

Sr. No.	Parameter	Unit	Sample Water (Before Treatment)	After Tube Settler Treatment	Permissible Limit (IS Standard)
1	Colour	_	Light Brown	Colourless	Colourless
2	Turbidity	NTU	18	5	5
3	pH	_	6.4	7.1	6.5- 8.5
4	Total Suspended Solids (TSS)	mg/L	42	14	20
5	Total Dissolved Solids (TDS)	mg/L	620	580	500
6	Dissolved Oxygen (DO)	mg/L	3.2	5.6	> 5
7	BOD	mg/L	6	2	3
8	COD	mg/L	18	8	10
9	Oduor	_	Unpleasant	Acceptable	Acceptable
10	Coliform (presence)	_	present	Reduced	Absent

VI. MITIGATION STRATEGIES FOR WATER POLLUTION

6.1. Treatment of Domestic Wastewater

Install proper sewage treatment systems before discharge. Use septic tanks or small-scale treatment units in residential areas. Reuse treated water for gardening and cleaning.

6.2. Industrial Effluent Treatment:

Industries should treat wastewater using Effluent Treatment Plants (ETPs). Strict monitoring of chemical discharge limits is necessary. Treated water should be recycled and reused wherever possible. [2] [9].

6.3. Use of Improved Treatment Technologies

Apply sedimentation aids like tube settlers to remove suspended solids. Use filtration, disinfection, and advanced

treatment methods. Upgrade old treatment plants with compact and efficient systems. [6] [11].

6.4. Control of Agricultural Runoff

Reduce excessive use of fertilizers and pesticides. Promote organic farming practices. Construct buffer strips near water bodies to reduce polluted runoff. [2] [8].

6.5. Solid Waste Management

Avoid dumping garbage into rivers, lakes, and drains. Promote segregation, recycling, and safe disposal of waste. Reduce plastic use and encourage reuse. [4] [12].

6.6. Rainwater and Stormwater Management

Construct proper drainage systems. Use sediment traps to prevent polluted runoff from entering water bodies. Encourage rainwater harvesting. [6] [11].

6.7. Public Awareness and Education

Enforce water pollution control laws. Conduct regular water quality monitoring. Penalize illegal discharge of pollutants. [5] [9].

6. 8. Government Regulations and Monitoring

Implement strict regulations for construction dust control and industrial emissions. Raise public awareness about the effects of dust pollution and encourage compliance with preventive measures. Encourage use of air quality monitoring devices in urban and industrial areas [8] [11].

6.9. Household-Level Mitigation

Use domestic water treatment units. Clean overhead tanks regularly. Avoid disposal of oils, chemicals, and medicines into drains [12] [13].

VII. RESULT

The home-scale tube settler was tested using domestic water containing visible suspended particles. After allowing water to pass through the tube settler, a noticeable improvement in water clarity was observed. The turbidity of the water decreased significantly, indicating that most of the suspended solids had settled effectively. For example, turbidity reduced from 18 NTU to 5 NTU, and the total suspended solids decreased from 42 mg/L to 14 mg/L.

The physical appearance of the water also improved, as it became colourless and free from any unpleasant odour. Other parameters such as pH and dissolved oxygen remained within acceptable limits or showed slight improvement after treatment. Overall, the tube settler demonstrated effective removal of suspended solids and turbidity, making the water much clearer and safer for domestic use. This indicates that tube settlers are a simple, low-cost, and efficient solution for improving water quality at the household level. [2] [5].

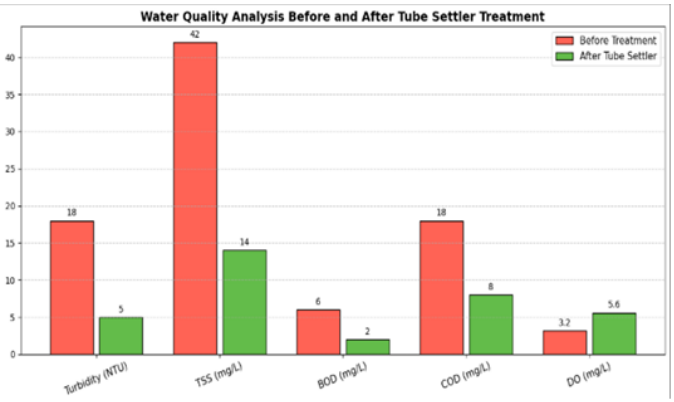

Fig -1: Water Pollution Analysis

VIII. CONCLUSION

Water pollution is a critical environmental challenge that negatively impacts human health, agriculture, infrastructure, and overall Water quality [3] [4]. The study and experimentation with the home-scale tube settler demonstrated that it is an effective and simple method for improving water quality at the household level. The tube settler successfully reduced turbidity, total suspended solids, and improved the physical appearance and clarity of domestic water. Chemical parameters such as pH and dissolved oxygen remained within acceptable limits, and some reduction in BOD and COD was observed, indicating partial removal of organic pollutants. [5] [8] [10]. Overall, the tube settler proved to be a low-cost, easy-to-construct, and efficient pre-treatment unit that can be implemented in homes to improve the performance of domestic water filtration systems. This project highlights that even small-scale sedimentation systems can significantly enhance water quality, making water safer and more suitable for domestic use. [9] [11].

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