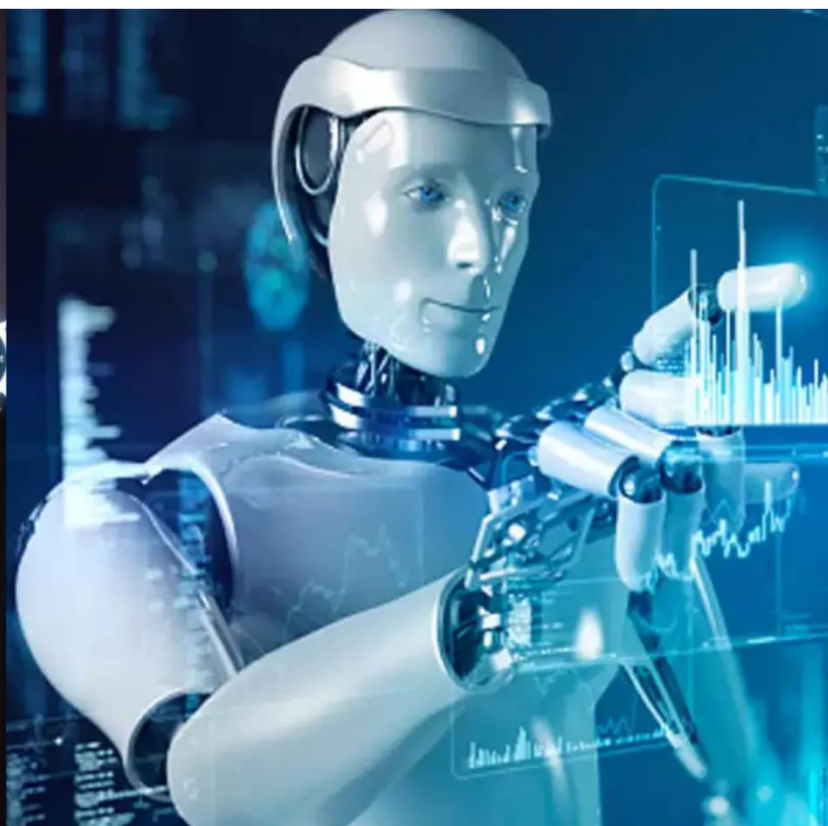




International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 3, March 2025

Increase the Dissolved Oxygen Level in Sewage Treated Water using Venturi Flume

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ABSTRACT: This research focuses on the design and development of a laboratory-scale Venturi flume to enhance dissolved oxygen (DO) levels in water, primarily for applications in sewage treatment plants (STPs). The Venturi effect is utilized to naturally increase DO levels, a critical factor in aquatic life sustainability and wastewater treatment. The study involves a comparative analysis between hydraulic jumps and Venturi flumes for aeration efficiency. Experimental investigations were carried out in a hydraulic tilting flume to evaluate DO levels before and after the flume section. The results indicate that the Venturi flume increases DO by 9-16%, making it a viable and energy-efficient method for improving water quality in treated effluent.

KEYWORDS: Venturi flume, dissolved oxygen, sewage treatment plant, hydraulic structure, aeration efficiency.

I. INTRODUCTION

Water is one of the most crucial resources for sustaining life on Earth. With the rapid expansion of urban centres and industrial activities, the contamination of natural water bodies has become an alarming issue. Untreated or poorly treated wastewater discharged into rivers, lakes, and oceans leads to severe environmental degradation, harming aquatic ecosystems and posing health risks to humans. The lack of proper wastewater management exacerbates this issue, making it imperative to develop efficient and sustainable water treatment solutions. One of the most significant parameters in evaluating water quality is dissolved oxygen (DO), as it plays a fundamental role in supporting aquatic organisms and maintaining the ecological balance of natural water bodies. Inadequate DO levels in treated sewage can lead to hypoxic conditions, which negatively affect marine life, promote the growth of harmful bacteria, and contribute to unpleasant odors in water bodies.

Traditional aeration methods, such as mechanical aerators, bubble diffusers, and cascade aeration, have been widely used to enhance DO levels in treated sewage. However, these methods are often energy-intensive, expensive to maintain, and may not be feasible for decentralized wastewater treatment plants or rural settings where power supply is unreliable. As an alternative, hydraulic structures such as weirs, hydraulic jumps, and Venturi flumes offer a passive and cost-effective means of increasing DO levels without requiring external energy sources. These structures utilize the natural principles of fluid mechanics to induce turbulence and promote oxygen transfer between air and water. Among these, the Venturi flume is particularly promising due to its ability to accelerate water flow through a constricted channel, thereby increasing turbulence and enhancing oxygen dissolution.

This study focuses on the application of the Venturi effect in improving the DO levels in sewage treatment plant (STP) effluent. By designing and testing a laboratory-scale Venturi flume in a controlled hydraulic environment, the study aims to assess its aeration efficiency and compare it with traditional aeration techniques. The findings of this research will contribute to the development of low-cost, energy-efficient aeration solutions that can be integrated into existing wastewater treatment infrastructure. If successfully implemented on a larger scale, Venturi flumes could help improve

the sustainability of wastewater treatment processes and ensure compliance with environmental regulations concerning effluent discharge.

II. LITERATURE SURVEY

Gameson (1957) was among the first to examine oxygen transfer in weirs and spillways. Avery and Novak (1978) developed expressions for aeration efficiency using Froude and Reynolds numbers. More recent studies by Kucukali and Cokgor (2009) established a linear relationship between energy dissipation rate and aeration efficiency. These studies highlight the potential of hydraulic structures to enhance DO levels without external energy input. An alternative approach involves utilizing hydraulic structures such as weirs, hydraulic jumps, and Venturi flumes, which leverage natural fluid mechanics principles to increase oxygen transfer efficiency. Natural aeration methods have been increasingly studied as sustainable solutions to enhance water quality. Various studies have demonstrated that hydraulic jumps, cascades, and weirs can significantly improve oxygen transfer efficiency. The self-aeration capability of hydraulic jumps, for example, has been extensively investigated by researchers such as Wilhelms (1981) and Gulliver (1990). These researchers established empirical relationships between aeration efficiency and energy dissipation rates. The efficiency of these natural aeration techniques depends on several parameters, including flow velocity, turbulence intensity, and air entrainment characteristics. While hydraulic jumps have been widely studied, the use of Venturi flumes for aeration remains relatively underexplored. The Venturi flume presents an interesting alternative, as it provides a controlled constriction in the flow, thereby inducing localized turbulence and enhancing oxygen transfer. The present study aims to bridge this gap by conducting experimental investigations on DO enhancement using Venturi flumes and comparing their efficiency with other traditional aeration techniques.

III. METHODOLOGY

A. Experimental setup:

The experiment was conducted in a tilting hydraulic flume at DATTA MEGHE COLLEGE OF ENGINEERING.

The setup included:

1. A transparent hydraulic flume (0.016m x 4.5m x 0.25m) for visual observation.
2. A prototype venturi flume placed at the test section.
3. A dissolved oxygen meter to measure do levels at upstream and downstream locations.

B. Procedure:

1. The flume bed slope was set to zero.
2. Fixed the venturi flume (Figure 1) in the tilting flume having dimension 40cm length x 20 cm shorter length.
3. Water was introduced at a controlled flow rate.
4. Samples were collected from upstream and downstream locations at hourly intervals.
5. Do was measured using the titration method.
6. Data was recorded for different discharges and environmental conditions.

IV. RESULTS AND DISCUSSION

The table 1.presents the variation in dissolved oxygen (DO) levels at the upstream and downstream sides of a Venturi flume over different times of the day. It also includes temperature, discharge rate, and the percentage increase in DO levels. The results indicate that DO levels consistently rise at the downstream side, confirming the effectiveness of the Venturi flume in enhancing oxygen dissolution. The highest percentage increase (16.02%) occurs at 6:00 PM, while the lowest (9.00%) is observed at 1:00 PM, which could be due to higher temperatures (34°C) reducing oxygen solubility. The trend shows that higher discharge rates contribute to better oxygenation, likely due to increased turbulence and air entrainment. However, temperature plays a crucial role, as higher temperatures correlate with lower DO increments, emphasizing the importance of optimal flow and environmental conditions for maximum oxygenation efficiency. Fig 1 showing the fixation of venturi flume in tilting flume.

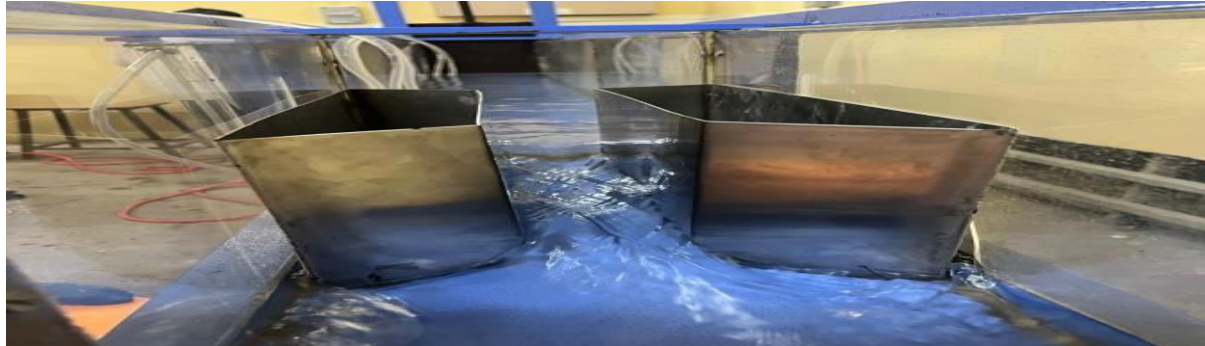


Fig. 1. Venturiflume prototype placed in tilting flume.

Table. 1 present's DO levels measured at upstream and downstream locations of the Venturi flume.

Timings	Dissolved oxygen level at upstream side in mg/lit	Dissolved oxygen level at downstream side in mg/lit	Temperature in degree Celsius	Discharge in m ³ /sec	% of increased dissolved oxygen level.
9.00 am	2.46	2.76	24	1.3	15.05
10.00 am	2.48	2.74	26	2.5	14.24
11.00 am	2.35	2.59	30	2.7	12.85
12.00 am	2.12	2.31	32	2.8	10.22
1.00 pm	2.04	2.18	34	3.0	9.00
2.00 pm	1.89	1.97	34	3.1	9.78
3.00 pm	1.95	2.08	32	3.4	9.93
4.00 pm	2.34	2.58	30	3.5	12.33
5.00 pm	2.52	2.89	28	3.6	15.87
6.00 pm	2.81	3.24	24	3.6	16.02

Observations:

- DO levels consistently increased at the downstream location.
- Higher temperatures correlated with lower DO levels.
- The Venturi flume improved "DO levels by 9-16% depending on flow rate and environmental conditions.

V. CONCLUSION

The study demonstrates that the Venturi flume is an effective method for increasing DO levels in water. The experimental results confirm that:

- DO levels improve significantly after passing through the flume.
- The system provides a low-energy alternative to traditional aeration methods.
- The increase in DO levels suggests that Venturi flumes could serve as an effective addition to wastewater treatment systems.
- The efficiency of the Venturi flume makes it a viable solution for improving water quality in both urban and rural sewage treatment plants.
- More research is necessary to refine the design, optimize parameters, and analyze its applicability in large-scale operations.

VI. FUTURE SCOPE

1. Optimization of Venturi Flume Design: Investigating the impact of varying throat width and angle on DO enhancement.
2. Material Selection: Exploring cost-effective, corrosion-resistant materials for long-term durability to enhance operational efficiency and lifespan.
3. Integration with STPs: Implementing Venturi flumes in full-scale STPs and monitoring long-term performance to validate its effectiveness in diverse conditions.
4. Renewable Energy Pairing: Assessing feasibility of solar-powered monitoring systems for real-time DO analysis, reducing dependency on conventional energy sources.
5. Computational Fluid Dynamics (CFD) Simulations: Conducting CFD analysis to predict and optimize flow characteristics within the Venturi flume for maximum oxygen transfer efficiency.
6. Field Studies and Case Studies: Deploying Venturi flumes in real-world STP settings to gather large-scale operational data and validate laboratory findings.

REFERENCES

1. Avery, S. & Novak, P. (1978). Aeration in Hydraulic Jumps.
2. Bureau of Indian Standards (BIS) IS 10500:2012 – Drinking Water Specifications.
3. Central Pollution Control Board (CPCB) Guidelines for Effluent Discharge, India. Dr. S. S. Kakde, Dr. Rajesh Kherde. (2022). Overview of Micro Scale for Large Scale River Basin. Seybold Report Journal, ISSN Number-469-487.
4. Dr. S. S. Kakde, Dr. Rajesh Kherde. Prediction of Water Quality Parameters Using ARIMA & WPFM. International Journal of Computer and Their Applications, ISSN Number-1076-5204.
5. Dr. S. S. Kakde, Dr. Rajesh Kherde. An Evolution of the Godavari River's Water Quality Index in Nashik, Maharashtra. International Conferences on Continuity, Consistency and Innovation in Applied Science and Humanities, Paper Id- ICCIASH2023/551.
6. Dr. S. S. Kakde, Dr. Rajesh Kherde. Water Quality Simulation and Water Quality Parameter Scenarios in Godavari River in Maharashtra. (ISBN 978-93-90150-30), International Research Conference on Science Technology, Engineering & Management.
7. Environmental Protection and Aquatic Life Regulations, Government of India.
8. Gameson, A.L.H. (1957). Oxygen Transfer in Hydraulic Structures.
9. Kucukali, S., Cokgor, S. (2009). Hydraulic Jump Aeration Efficiency. Journal of Environmental Engineering, ASCE.



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