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Performance Evaluation of an Industrial Effluent Treatment Plant for Pollution Reduction: A Case Study of Karmayogi Ankushrao Tope Samarth Sahakari Sakhar Karkhana (KATSSSK), Jalna

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Abstract:

This study evaluates the performance of the industrial effluent treatment plant (ETP) at Karmayogi Ankushrao Tope Samarth Sahakari Sakhar Karkhana (KATSSSK), Jalna, focusing on pollution reduction efficiency. Monitoring was conducted over a 25-day period, assessing key physico-chemical parameters including pH, chemical oxygen demand (COD), total dissolved solids (TDS), chlorides, and temperature. A unit-wise analysis was performed across the various treatment stages to quantify pollutant removal efficiency. All analyses followed standard procedures outlined by the APHA guidelines. The treated effluent quality was benchmarked against regulatory discharge standards prescribed by the Maharashtra Pollution Control Board (MPCB). Results demonstrate a progressive decrease in pollutant concentrations through successive treatment units, with final effluent parameters largely within permissible limits. The findings underscore the efficacy of the existing treatment system and highlight the importance of detailed unit-wise performance evaluations for enhancing environmental management practices in sugar industries.

Keywords: Effluent Treatment Plant, Sugar Industry, Pollution Reduction, Unit-wise Performance, Industrial Wastewater

Introduction:

The sugar industry plays an important role in agro-industrial development, particularly in regions where sugarcane cultivation forms a major part of the rural economy. Along with economic benefits, sugar manufacturing activities generate considerable quantities of wastewater containing high concentrations of organic matter, dissolved solids, and process-related contaminants. The characteristics of this waste water vary with production stages and operational practices, making its management a critical environmental challenge.Wastewaterproducedduringsugarprocessingoriginatesfromoperations suchas cane washing, Juice extraction, evaporation, and equipment cleaning. If discharged without adequate treatment, such effluent can adversely affect surface water bodies and surrounding soil by increasing organic load and altering physicochemical conditions.

To prevent environmental degradation and comply with regulatory requirements,

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sugar industries employ effluent treatment plants (ETPs) designed to reduce pollutant concentrations prior to discharge. Wastewater produced during sugar processing originates from operations such as cane washing, juice extraction, evaporation, and equipment cleaning. If discharged without adequate treatment, such effluent can adversely affect surface water bodies and surrounding soil by increasing organic load and altering physicochemical conditions. To prevent environmental degradation and comply with regulatory requirements, sugar industries employ effluent treatment plants (ETPs) designed to reduce pollutant concentrations prior to discharge.

An industrial ETP typically consists of a series of treatment units that function collectively to achieve pollution reduction. The effectiveness of each unit depends on wastewater characteristics, operational stability, and process efficiency. While compliance monitoring generally focuses on final treated effluent quality, evaluating performance at individual treatment units provides a clearer understanding of pollutant removal mechanisms and system efficiency. Unit-wise assessment is therefore essential for identifying critical treatment stages and optimizing overall ETP performance.

Although several studies have reported treated effluent quality of sugar industry wastewater, limited research has emphasized unit-wise performance evaluation based on continuous field data. In this context, the present study focuses on the performance evaluation of the industrial effluent treatment plant at Karmayogi Ankushrao Tope Samarth Sahakari Sakhar Karkhana (KATSSSK), Jalna. The study uses 25 days of monitoring data for physicochemical parameters to assess pollution reduction efficiency across different treatment units and to evaluate compliance with prescribed discharge standards.

Materials and Methods:

1. Study Area

The study was conducted at the effluent treatment plant of Karmayogi Ankushrao Tope Samarth Sahakari Sakhar Karkhana (KATSSSK), located in Jalna district, Maharashtra, India. The ETP treats wastewater generated from various sugar manufacturing operations before discharge. The treatment system comprises multiple units designed to progressively reduce pollutant concentrations.

2. Sampling and Monitoring

Effluent samples were collected from different treatment units of the ETP over a monitoring period of 25 days. Sampling locations varied depending on the relevance of the parameter and the monitoring practices followed at the industry. Unit-wise sampling enabled assessment of pollutant reduction across individual treatment stages. Grab samples were collected and analyzed on the same day to avoid changes in water quality.

3. Analytical Methods

The collected samples were analysed for selected physicochemical parameters

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including pH, chemical oxygen demand (COD), total dissolved solids (TDS), chlorides, and temperature. All analyses were carried out following standard procedures recommended in Standard Methods for the Examination of Water and Wastewater (APHA). The observed treated effluent values were compared with discharge standards prescribed by MPCB.

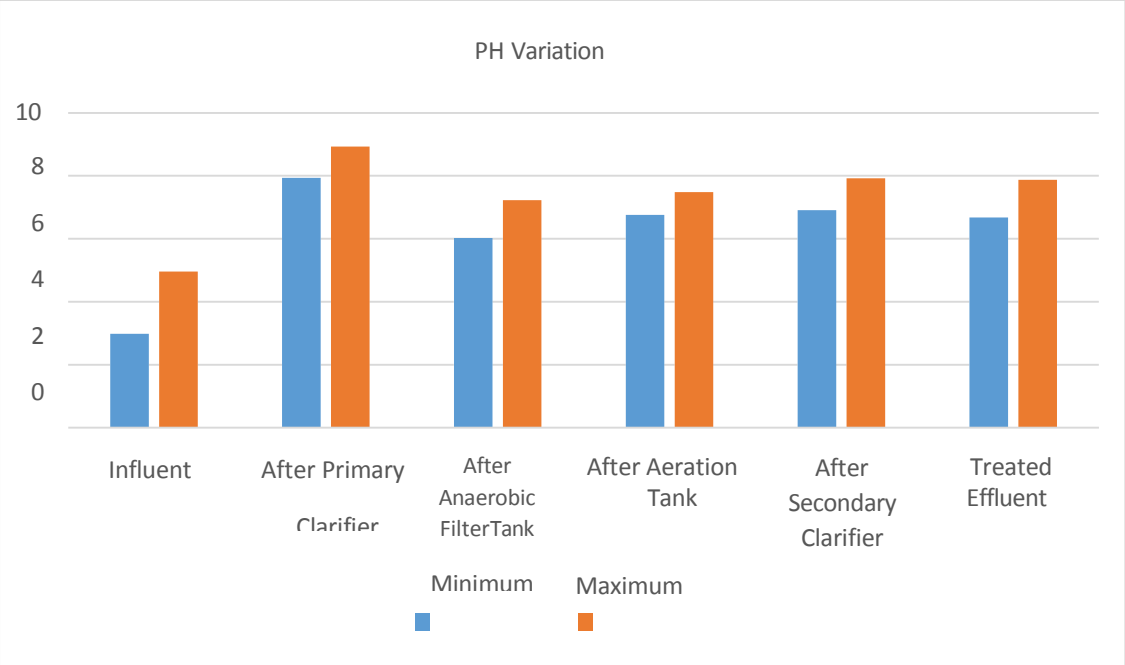
Result and Discussion:

Table1: Average reading of 25 days

Sr. No.	Parameters	Raw Effluent	Treated Effluent	Limiting conc. Not to exceed in mg/l, except for pH
1	**pH**	2.98-4.96	6.67-7.88	5.5-9
2	**COD**	6368	312	250
3	**Chloride**	323.2	261.6	600
4	**TDS**	1610	1424	2100
5	**Temperature**	29.4	23.9	NA

1. pH Variation

The pH values observed across different treatment units indicated relatively stable conditions throughout the monitoring period. Minor fluctuations were observed between units due to biological activity and treatment processes. The pH of the treated effluent remained within the permissible limits specified by regulatory authorities, in dictating effective buffering capacity of the treatment system. Stable pH conditions are essential for optimal biological treatment performance.



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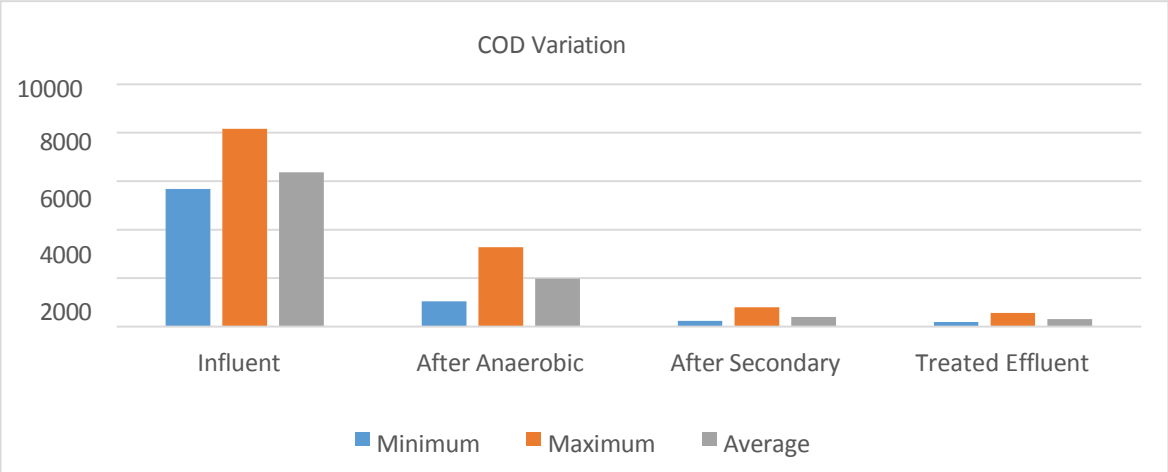
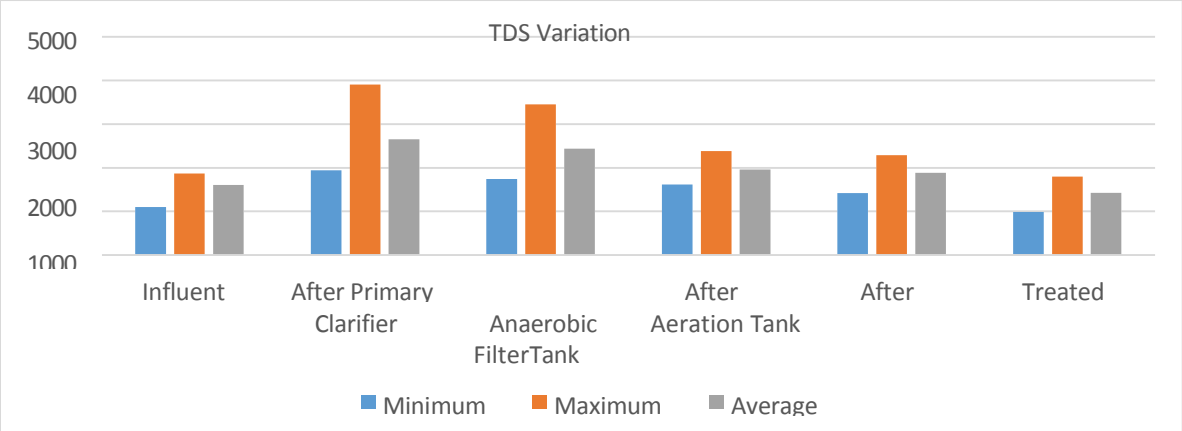
2. COD Reduction Performance:

Chemical Oxygen Demand (COD) is a key indicator of organic pollution strength in sugar industry wastewater. Unit-wise analysis revealed a progressive reduction in COD concentration across the treatment units. Significant COD removal was observed during biological treatment stages, highlighting the effectiveness of anaerobic and aerobic processes in degrading organic matter. The final treated effluent COD values showed substantial reduction compared to upstream units and largely complied with prescribed discharge standards. These results are consistent with findings reported in earlier studies on sugar industry ETP performance.



3. TDS Variation

Total Dissolved Solids (TDS) values exhibited comparatively smaller variation across treatment units. Limited reduction in TDS concentration was observed, which is expected since conventional biological treatment processes are not specifically designed for dissolved solids removal. The treated effluent TDS values were influenced by process water characteristics and chemical usage. Despite limited removal, the final effluent values remained within acceptable discharge limits



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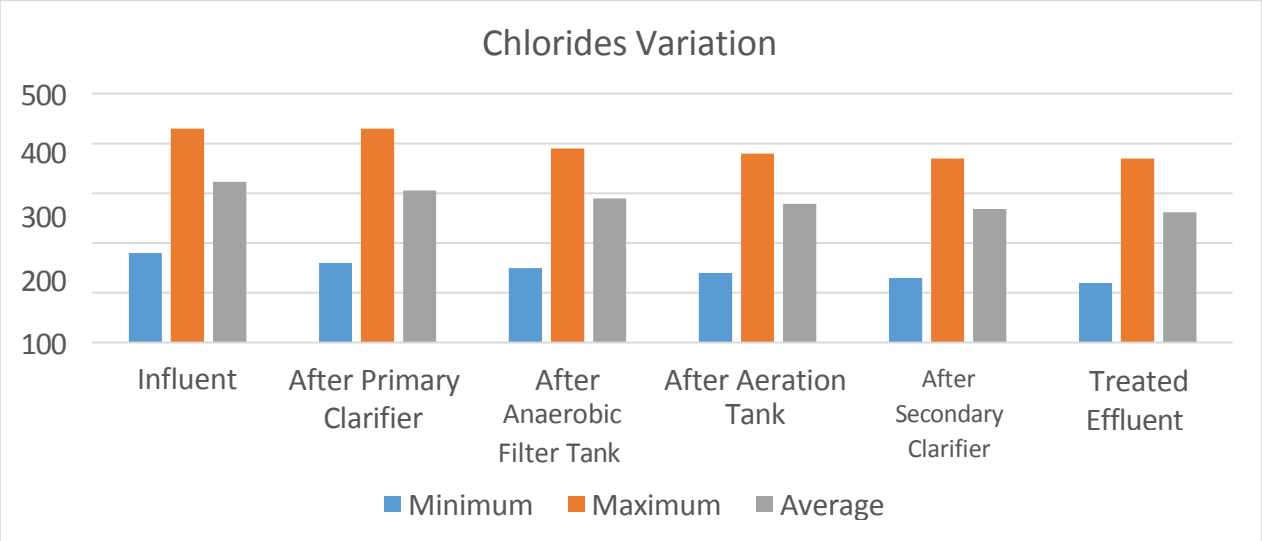
4. Chloride Concentration

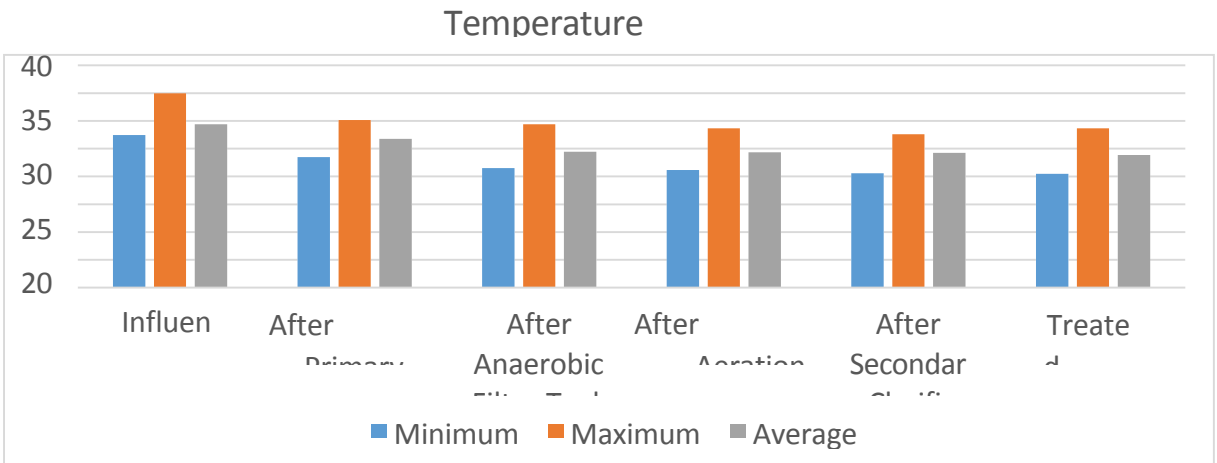
Chloride concentration showed conservative behavior across treatment units, with minimal reduction observed. Chlorides are generally not removed effectively through biological treatment and tend to remain stable throughout the process. The observed trends reflect the inherent nature of chloride ions and are in agreement with literature findings. The treated effluent chloride levels were within permissible limits, indicating no adverse environmental risk from salinity perspective.



5. Temperature Variation

Temperature measurements showed minor variation across treatment units, primarily influenced by ambient conditions and process operations. The treated effluent temperature complied with regulatory discharger requirements. Maintaining appropriated temperature is important for sustaining biological activity and overall ETP performance.

Conclusion:



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The present study evaluated the performance of an industrial effluent treatment plant at Karmayogi Ankushrao Tope Samarth Sahakari Sakhar Karkhana (KATSSSK), Jalna, through unit-wise analysis of key physicochemical parameters over a 25-day monitoring period. The results clearly demonstrated effective pollution reduction, particularly in terms of organic load removal. The overall COD removal efficiency of the ETP was observed to be 95%, indicating excellent performance of the treatment system.

Unit-wise COD analysis revealed that the anaerobic treatment unit contributed significantly, achieving a COD reduction of 68.84%, followed by further removal in the secondary treatment unit (79.77%). The final polishing and treated effluent stage contributed an additional 22.25% reduction, ensuring compliance with prescribed discharge standards. This progressive reduction highlights the critical role of biological treatment processes in the effective degradation of organic pollutants in sugar industry wastewater.

In contrast, TDS and chloride removal efficiencies were comparatively lower, with overall reductions of 11.55%and 19%, respectively. This behavior is expected, as conventional biological treatment processes are not specifically designed for the removal of dissolved inorganic constituents. Nevertheless, the treated effluent concentrations of TDS and chlorides remained within permissible regulatory limits, indicating acceptable environmental performance.

Overall, the unit-wise performance evaluation provided valuable insight into the pollutant removal mechanisms operating within the ETP. The study confirms that the existing treatment system at KATSSSK is effective in achieving substantial pollution reduction and regulatory compliance. The findings emphasize the importance of continuous monitoring and unit-wise assessment to optimize treatment efficiency and support sustainable wastewater management in sugar industries.

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