PERFORMANCE EVALUATION OF EFFLUENT TREATMENT PLANT (OCM PVT. LTD., AMRITSAR)

A Dissertation

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Submitted by

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DECLARATION CUM CERTIFICATE

I hereby declare that the dissertation entitled **Performance Evaluation Of EFFLUENT TREATMENT PLANT (OCM Pvt. Ltd., Amritsar)** is an authentic record of my own work carried out at **OCM Ltd, Amritsar** as requirements of project internship from July 2024 to June 2025 for the award of degree of M.Tech. (Environmental Science & Technology), TIET, Patiala, under the guidance of Mr. Rajesh Sharma, HOD - engineering, OCM Pvt. Ltd. and Mr. K.S Babu (Assistant professor, Thapar Institute of Engineering & Technology) & Dr. Gaurav Goel (Assistant professor, Thapar Institute of Engineering & Technology).

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Certified that the above statement made by the student is correct to the best of our knowledge and belief.

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Abstract

Performance Evaluation of EFFLUENT TREATMENT PLANT was conducted **at OCM Pvt.Ltd.Amritsar** during the period July 2024 - June2025.

Manufacturing process adopted and scheme commissioned for the effluent generated was understood initially. The basic principles of **Software NOW, its application for** handling purchase and sale, warehouse modules and meeting the major requirements of textile industry were thoroughly learnt.Influent (from inlet) and effluent(from outlet) were analyzed twice weekly from Dec2024 to May 2025 (6 months) for the parameters pH, temperature, Total dissolved and suspended solids, BOD and COD. During this study period, the temperature ranged from 32.2°C to 34.33°C. The pH value was between 7.12 and 7.38.The TDS concentration was observed between 1895 mg/l and 1990 mg/l, while the TDS removal efficiency ranged between 13.25 % and 40.50%. The BOD removal efficiency ranged from 64.44 % to 83.33 %,.The COD removal efficiency ranged from 70.77 % to 77.78 %. All the effluent quality parameters were within permissible standards of PPCB, except the TDS levels. The study has shown a possibility to work further on techniques of TDS removal, kinetics development, techno-economics of treatment etc.,

(Keywords: industrial effluent, effluent quality, characterization, BOD, COD, TSS, TDS, treatment plant, textile industry etc.)

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Chapter 1: Introduction

The primary goal of the textile or clothing sector is to design and produce contemporary, chic fiber, thread, textiles, clothing, and attire, along with their supply and distribution. One among India is one of the top exporters of textiles and clothing globally. India's textile and apparel sector plays a crucial role in the national economy, generating jobs that are both direct and indirect.

The textile and apparel industry represents 14% of manufacturing production and 3% of the nation's GDP. The textile sector accounts for as much as 21% of the economy labor force. The industry directly employs approximately 35 million people. Indirect employment refers to workers involved in agricultural raw material production, such as cotton, as well as related trade and handling activities which may account for another 60 million jobs. Thus, growth and all around development of this industry has a direct impact on India's economic growth. There are 1,227 textile mills, with a spinning capacity of approximately 29 million spindles. Yarn is primarily produced through power looms and handlooms. Cotton remains the primary raw material in India's textile industry, accounting for approximately 65% of total consumption. Cotton cloth was produced annually at rate of approximately 12.8 billion meters (42 billion feet). Jute production (1.1 million metric tons) follows cotton weaving as the second most important sector.

About 200 liters of water are needed on average to supply one kilogram of textiles. If left untreated, when textile waste is discharged straight into surface water bodies, its elevated BOD levels can swiftly reduce the dissolved oxygen levels. Biological life is significantly compromised by wastewater containing high levels of BOD and COD. Aquatic organisms are adversely affected by elevated alkalinity levels and small amounts of chromium utilized in dyes, which also interferes with biological treatment methods.

The wet processes—scouring, mercerizing, bleaching, dyeing, and finishing—are the main sources of chance variables and are involved in production large quantum of wastewater.
Hence, it is necessary to treat the wastewater produced by textile industries before releasing it into the environment. This is accomplished by introducing a variety of physical and chemical methods.. Aerobic biological treatment may come after physiochemical treatment in the wastewater

treatment facility. It included the following primary and secondary treatment unit operations: equalization basin, chemical dosing tank, primary clarifier, aeration tank, secondary clarifier, and sludge drying bed, ACF and PSF.

The performance of treatment plants is assessed by characterizing the effluents produced during treatment. The analysis results in terms of physical, chemical and biological parameters give precise picture of how well ETP is doing and, if needed, the required steps to prevent negative environmental effects.. The overall performance is also assessed by knowing the efficiency of individual treatment units..

OCM Pvt.Ltd is located at Chheharta, Amritsar, Punjab and is majorly involved in producing textiles such as worsted fabrics, woolen tweeds etc. The essential steps involved in textile production are weaving, spinning, dyeing and finishing.

Effluent treatment Plant adopted at the industry is shown in Fig 1.1

Figure 1.1: ETP (OCM Pvt. Ltd., Amritsar, Punjab) using conventional ASP

During the study period from July 2024 to June 2025, Performance evaluation of Effluent treatment plant was carried out at the industry. The work elements involved were as follows:

- Study of textile manufacturing processes and scheme for effluent treatment

- The basic principles of **Software NOW, its application for** handling purchase and sale, warehouse modules and meeting the major requirements of textile industry.
- Characterization of influent and effluent quality parameters (Essential parameters to be satisfied for meeting PPCB regulations such as temperature, pH, TDS, TSS, BOD and COD)

Chapter 2: Review of Literature

Madan.et,al,2024 indicated that textiles account for around 14% of all industrial production, and this sector is most important in the Indian economy.

The information available from research papers, e-resources on characteristics of textile effluents, treatment technologies adopted, research done is presented below.

2.1 Characteristics of Effluent

Due to its elevated BOD level, untreated textile wastewater can rapidly consume dissolved oxygen if it is discharged into surface water bodies. Elevated BOD and COD concentrations in wastewater are highly detrimental to living organisms. Both physio-chemical and biological analyses can be used to evaluate the effluent's quality. It is necessary to have the accurate idea of the composition of effluent to accurately evaluate the performance of ETP. Monitoring the effluent's environmental parameters would enable accurate performance evaluation of ETP at any moment, and if required, appropriate action could be taken to avoid negative environmental effects. They can also be used to develop plans for better plant waste minimization and textile industry processes. (Madan, et al., 2024)

2.2 Effects on environment and human health

Textile wastewater treatment facilities can use physicochemical treatment processes of flocculation and coagulation to decolorize effluent and lower the overall load of contaminants. The primary benefit of the coagulation-flocculation process is that it may decolorize textile wastewater by removing dye molecules from the effluents rather than by partially breaking down colors, which could result in the production of poisonous and potentially hazardous aromatic compounds. Inadequate treatment resulting from improper chemical dosing, inactivity or even death of essential microorganisms due to inadequate oxygen or nutrients, overloading the treatment plant's capacity, and operating conditions that deviate from intended values were the causes of lower efficiencies. The substantial quantity of environmental deterioration and human diseases is caused by textile effluent. Organically bonded chlorine, a recognized carcinogen, is present in around 40% of colorants used. Chemicals can affect children before they are even born by evaporating into the air they breathe or by being absorbed through skin. They can manifest as allergic reactions. Additionally, it causes impairments in reproduction, respiration, osmoregulation, and even mortality. Thus, by negatively impacting the natural ecosystem and having long-term health repercussions, untreated textile effluent can be dangerous to aquatic and terrestrial species.

The flocculation and coagulation technique is recognized for its high ability to function and be maintained. The selection of coagulant aids is determined by the cost, availability, and compatibility of the specific waste. Typically, alum, polyelectrolyte, and lime were employed as coagulants. The process of coagulation and flocculation removes dye and heavy metals, but the issue with this method is that traditional aluminum-based coagulants may be linked to Alzheimer's disease. (C, Y.M., Kumar, et al., 2018)

2.3 Treatment technologies for effluent

2.3.1 Physico-chemical methods

Coagulation, adsorption, filtration, and ion exchange are among the various physicochemical techniques that have been developed.

One well-known physicochemical method for eliminating contaminants from textile effluent water is the coagulation process. Iron salts and alum are used as coagulants to improve wastewater's microscopic particles that clump together to form larger ones. When reactive and vat dyes are present in water, these methods also perform poorly. Both flocculation and coagulation have drawbacks due to their poor dye removal capabilities and the massive volume of sludge generated as by-products.

Sorption technology is highly effective in eliminating a variety of dyes from wastewater. The choice of adsorbents for the color reduction process is essential because of the significant affinity, ability, and essential characteristics of adsorbent selection criteria. Due to its adequate commercial activated carbon is an efficient adsorbent due to its surface area and adsorption capacity removing colorants. Nonetheless, its use is restricted due to its high price and the challenges of reprocessing or release.

Several scholars have employed inexpensive adsorbents like bentonite, zeolite, and ash, biomass residues and resins for adsorption. Furthermore, numerous studies were conducted utilizing various biomass residues—including rice husks, wheat byproducts, altered ginger waste, and so on— that are used as adsorbents to extract color from wastewater effluent in textiles.

Employing inexpensive adsorbents for decolorizing wastewater that contains dyes, the subsequent findings were documented. In a study, Reactive Red-24 (RR-24) was removed using altered wheat residue (AWR) as a sorbent. Modified ginger waste (MGW) was utilized to obtain eliminate crystal violet (CV) dye. In another study, Reactive Orange 84 was removed utilizing activated carbon produced from discarded cotton flower remnants. Adsorbent (waste from potato plants) was employed to take in dye (methylene blue and malachite green). Activated carbon produced from discarded tea. (ACWT) served as the adsorbent for the adsorption of acid blue 25 (AB25). Straw-derived absorbent was employed for the adsorption of methylene blue. Ash from sugarcane bagasse adsorbed Acid Orange II. Capsicum Annuum seeds absorbed Reactive Blue 49. Bagasse fly ash was utilized to capture Orange-G and Methyl Violet colorants.
(Adane, et al., 2021)

However, there have been few uses for these adsorbents due to their regeneration or desorption, dumping, high cost, and other issues. As a result, adsorbents can be utilized in adsorption methods with low initial pollutant concentrations or when they are readily available, inexpensive, and easily produced or desorbed.
(Adane , et al., 2021)

Filtration methods such as reverse osmosis (RO), microfiltration (MF), and nanofiltration (NF), Ultrafiltration (UF) have been utilized to eliminate pollutants from textile wastewater. The selection criteria for the filter media and their capacity to take into account the chemical composition and temperature of textile wastewater are crucial for the removal methods. Membrane Technologies are implemented in textile factories to reduce wastewater output.

Nonetheless, there exist also significant disadvantages that require further intervention, including the upfront investment expense, membrane blockage, and waste production from water-insoluble dyes and starch utilization membranes for color removal.
(Adane, et al., 2021)

Ion exchange is utilized to eliminate cation and anion contaminants from wastewater. In the ion exchange process, synthetic resins are frequently employed. The ion exchange method is extensively utilized for easing rigid water. Nonetheless, its capacity to eliminate dye from water has been restricted. The advantage of this approach is that no adsorbents are wasted. It could be used to get rid of dyes that are soluble in water. However, it is not very effective for water-insoluble pigments, such as dispersion dyes.
(Adane , et al., 2021)

2.3.2 Methods involving Chemical Treatment

Dangerous pollutants like dye, toxic metals, and unpleasant smells are often removed from industrial wastewater discharge through chemical treatment methods. Chemical oxidation and enhanced Oxidation processes (AOP) comprise two types of chemical treatment techniques. Hydroxyl radicals are generated in significant amounts during AOP. Various oxidizing agents, such as Cl, O_3 ,ClO_2, and H_2O_2 is utilized for the treatment of wastewater. Oxidizing agents are used to target the chromophore. Hydroxyl radicals are powerful oxidizing agents. Most dyes possess a high level of reactivity with hydroxyl radicals. Furthermore, they are capable of oxidizing both organic and inorganic pollutants. Fenton's reagent and photocatalytic oxidation methods are additional AOP methods. Fenton's reagent, consisting of iron salts, is utilized to enhance the oxidation of complex organic pollutants that are tough to break down biologically by accelerating the decomposition of H_2O_2. Due to the aggregation of reagent and dye molecules, the Fenton .This method results in iron sludge as a byproduct.
(Adane, et al., 2021)

Oxidizing chemicals such as O_3 and H_2O_2 were added during the chemical oxidation process. Synthetic colors can be successfully removed from effluents using the ozonation process, a chemical technique. The conjugated double bond of azo dyes, which gives the dyes their color, is

broken by the ozone gas's activity during the ozonation process. The main advantage of the ozonation process is that it generates no solid waste as a byproduct, and the volume of wastewater remains the same, and ozone can be utilized in a gaseous state. Moreover, the main disadvantage of using ozone gas is that it may produce dangerous pollutants as byproducts, even from biodegradable dyes in wastewater. The high expense and short half-life of the ozonation method that is just ten minutes immersed in water at pH 7 present additional disadvantages. The pH level, salt concentration, and temperature and the stability of the ozonation process is influenced by wastewater.
(Adane, et al., 2021)

UV light boosts the production of large amounts of hydroxyl radicals, enabling it to be possible to purify wastewater by mixing H_2O_2 with UV light to eliminate color. Due to its lack of production solid waste or odor, employing UV light and H_2O_2 simultaneously to eliminate dye from wastewater that contains dye is preferred. Here, we employ UV light to accelerate the breakdown of H_2O_2 into hydroxyl radicals. During the chemical oxidation process, hydroxyl radicals induce organic and inorganic contaminants to mineralize into CO_2 and H_2O . To achieve a better rate of dye removal, the key operational factors—such as pH, UV radiation intensity, dye molecule structure, and dye bath composition—must be tuned. (Adane, et al., 2021)
Using an eggshell-based (Pd@CaO) nanocomposite adsorbent as a precursor, crystal violet (CV) dye was extracted from water when exposed to sunlight. It was studied how to eliminate Methylene Blue by applying the Co (II) complex@ZnO under solar irradiation. Indigo carmine dye was removed using a new composite silver nanoparticle loaded calcium oxide adsorbent under photocatalytic conditions. (Adane, et al., 2021)

Numerous researchers conducted the subsequent studies utilizing combination therapy methods. To eliminate Rhodamine dye from water, hybrid H_2O_2, CCl_4, and Fenton's. Reagents were examined, along with mixtures of TiO_2/UV/ H_2O_2 for the elimination of azo dye. The elimination of Reactive Red 120 dye (RR120), the kind of oxidation method and its outcome were analyzed. Additionally, since an increased number of hydroxyl radicals are produced during the dye oxidation in the process, incorporating H_2O_2 speeds up the deterioration rate. Pursuing the ideal at higher concentrations of H_2O_2, the elimination of dyes was not enhanced any further.

(Adane, et al.,2021).

2.3.3 Biological Treatment Processes

The organic substrates in textile effluent wastewater are eliminated by applying the biodegradation method. Color deterioration began with bacteria over several years ago. Although it includes a complicated mechanism, the breakdown of synthetic colors by bacteria is simple to handle. Microorganisms need the right environment and depth knowledge to grow. The amount of organic materials, such as dye, the load of microorganisms, the temperature and pH of the waste, and the amount of dissolved oxygen in the system all affect how well the degrading process works. Biological approaches can be facultative, anaerobic, anoxic, or a combination of these. The following benefits of the biodegradation process over physical and chemical approaches include: full mineralization into harmless end products; minimal infrastructure and operating expenses; low solid wastes; and environmental friendliness.

The selection of microorganisms and their function Enzymes influence the efficiency of the biodegradation process. Consequently, numerous microorganisms and Enzymes have been identified and evaluated for their capacity to eliminate dyes.

A key biological element in the treatment of textile wastewater is the identification of potential bacteria and their later removal. A variety of microorganisms, such as bacteria, fungi, and algae, eliminate various types of colors from textile wastewater. Utilizing Fungi for Dye Elimination, a fungus's Metabolism can be modified to adapt to changing environmental conditions. Consequently, both within the cell and external enzymes aid metabolic functions. The liquid from textile wastewater that has been decomposed by enzymes exhibits a range of colors. Fungal cultures seem to be a suitable criteria for eliminating colors from fabrics. Manganese peroxidase and lignin peroxidase (LiP), White-rot fungi and Phanerochaete chrysosporium have mainly been utilized to break down colors from fabric. Azo dyes can be broken down by white rot fungus cultures. Fungi culture was used to remove the disperse dye Solvent Red 24.

A fungus culture (the white-rot fungus Pleurotus eryngii) was used to remove the naphthalene coloring. However, the lengthy development phase, the need for nitrogen-restrictive conditions, the unpredictable generation of enzymes, and the large reactor size are the drawbacks of employing white-rot fungi to remove colors from wastewater. When using fungi alone, the system becomes unstable and, after a few days, roughly 20 to 30, bacteria will begin to grow and the fungi will no longer be able to dominate the system, which will decrease the system's ability to remove dyes.

Algae for Dyes Removal can be classified as macroorganisms, such as plants or vegetables, or microbes. Common habitats for algae include rivers, lakes, and ponds. All algae use energy from the sun to produce food. Common names for macroalgae include phytoplankton and seaweed. Three distinct methods are used to remove color using algae: chromophores sorption onto the surface of algae, enzyme conversion of dyes into noncolored products, and the consumption of dyes by algae for their growth. Biosorption and biodegradation are two distinct processes.

The biosorption process involves the transfer of dye molecules from the liquid phase to the solid phase. (adsorbent); the biodegradation process involves enzymes breaking the bonds of dye molecules, which permits the dye molecule to transform into different byproducts. Elevated concentrations of sodium chloride and several humic acid azo dyes, including acid red 27, can be observed in wastewater and are utilized to remove color from Shewanella algae (SAL) .

Using green macroalgae like Enteromorpha sp., ideal circumstances for the degradation of Basic Red 46 from wastewater were studied. These included a temperature of 25°C, an initial dye concentration of 15 mg/L, a dose of algae of 2 g, and a reaction period of 5 hours. Additionally, delete the alternate biosorption procedure that uses algal waste for color instead of commercial activated carbon. (Adane, et al., 2021)

Studying the removal of dyes by bacteria in an aerobic environment was also reported. They used azo-reductase enzymes in an anaerobic setting to remove predominantly azo dyes due to the reductive breakdown of azo dyes. Anaerobic or aerobic methods are used to further treat the potentially colorless and poisonous intermediates that are produced when azo bonds (-N=N-) break. Alcaligenes faecalis PMS-1, Enterobacter sp. EC3, and Aeromonas hydrophilia are examples of single bacterium cultures that have recently been created for the biodegradation of colors from textile effluent wastewater. (Adane, et al., 2021)

A single bacterium culture can accelerate the deterioration of textile effluent's colors and limit its duration. Using a bacterial culture (MI2), the colors acid orange 7 and acid orange 8 were extracted from water. Blue Bezaktiv was removed from wastewater by employing bacterial culture Bx .

Employing a bacterial culture (Enterobacter sp. F NCIM 5545), Reactive Blue 19 dye was eliminated from H_2O. The color Reactive Orange 16 (RO16) was obtained from water utilizing bacterial culture. DAS. Proteus mirabilis LAG was utilized to eliminate Reactive Blue 13 (RB13) dye from water. microbial culture. Crystal violet and brilliant green dyes were utilized to remove malachite green. from microbial cultures (Kurthia sp). Operational parameters, including dissolved oxygen, temperature, solution pH, beginning color intensities, dye structure, nitrogen sources, redox mediator, and electron donor quantity, influence how bacteria break down colors. Therefore, it is crucial to ascertain the impact of each design aspect on the biodegradation reactor in order to achieve efficient output and quick bacterial degradation. (Adane, et al., 2021).

2.3.4 Biological treatment methods along with chemical oxidation treatment methods

Treating certain dye molecules and various water-soluble substances from textiles is difficult. Sector utilizing solely biological methods at different phases of wet processing. Specific pigment Chemical treatment does not always completely eliminate molecules from textile effluent water. Techniques, and the equipment may be expensive because of the requirement for additional energy sources such as UV light And chemical agents such as Fe.3+, H2O2, and oxidizing substances. Consequently, chemical oxidation serves as a subsequent step.

Treatment and biological treatment methods used as a preliminary step, or possibly the reverse, are the only alternative methods that can lead to complete eradication. The advantage of the pretreatment method is that it can be employed to partially oxidize non- biodegradable contaminants, including dye molecules and various toxic substances, to generate biodegradable materials, depending on the elements of the textile wastewater discharge. It exists essential for processing to decrease energy usage, chemical consumption, and operating costs. A variety of combinations of chemical oxidation and biological treatment methods have been recorded in the literature. To eliminate COD and TOC from wastewater generated by textile effluents, biological treatment was integrated with chemical treatment methods. Elevated surfactant levels and hue elimination occurs from the integration of biological methods and chemical methods approaches (Ozonation succeeded by sequencing batch biofilter granular reactor).

(Adane , et al., 2021)

Reactive Red-120 (RR-120) was eliminated from textile effluent wastewater using a combination of chemical and biological treatment techniques. It has been documented that azo dye AR18 may be eliminated from textile effluents by combining chemical and biological treatment techniques (SBR and improved Fenton process as post treatment). Reactive Red 180, Reactive Black 5, and Remazol Red RR dyes may be eliminated from water using a combination of chemical and biological treatment techniques. There have also been reports of the removal of several colors using combined biological and chemical treatment techniques, including the reactive azo dyes Red Intracon CD-3SR, Yellow Reactron 4GL, and Navy Blue Intracon US-B Ultra. (Adane, et al., 2021)

A few studies were published via ozonation, photo-Fenton, and $H_2 O_2$. Consequently, the chemical treatment approach is used either as a pretreatment or as a post treatment. The biological approach was used as a pretreatment to remove the biodegradable pollutants from textile wastewater effluents, and the advanced oxidation process, as described by.

A chemical approach was utilized as a subsequent treatment to eliminate the non-biodegradable contaminants. The kind of contaminants in wastewater, the standard of the final product, and the cost of the tech innovations. All affect by what way or means one or multiple chemical processes are integrated with others. The technologies, including biological processes at times, the results of using the chemical treatment approach as a pre- or post-processing in hybrid phases is less clear-cut or even more challenging to analyze alongside the properties of actual textile wastewater.

A systematic way is necessary to assess how the occupational environment—like contact time, initial oxidant concentration, type of catalyst, solution pH, and additional factors—impact the current effluent temperature features during the preprocessing phases. The primary goals of integrating chemical and biological treatment methods as pre- or post-treatment are to reduce investment expenses and deliver top-notch outcomes.

2.4 Difficulties and Prospects with textile industies

The textile industries have been divided into two groups: (i) the compliant textile industry, which refers to the industry that maintains sustainability indicators and effluent treatment plants, and (ii) the non - compliant industry, which refers to the industry that does not maintain sustainability indicators and effluent treatment plants. Greer and Hook (2014) also contend that stricter regulation and oversight of manufacturing standards are obviously necessary, especially in light of the continuous chemical spills into neighboring rivers from the compliant textile industry's dyeing and finishing operations.

Common issues including lack of government rules and budgetary restrictions highlight the need for more robust control. There is need for more stringent oversight, especially in emerging economies where non-compliant industries have been releasing untreated effluents into water bodies, increasing environmental degradation and health risks. The compliant textile industry follows sustainable practices, which are made possible by effluent treatment facilities that prioritize resource efficiency, sustainability compliance, and environmental benefits.

Moreover, stringent government oversight is required to control and track the actions of unsustainable textile wastewater discharges to support socioeconomic development and environmental sustainability. For instance, the European Commission (2015) addressed the difficulties in implementing eco-friendly technologies in the fashion industry, including the lack of skilled workers and the financial constraints faced by small and medium-sized businesses.

The literature presented from sections 2.1 to 2.4 has discussed the characteristics of textile wastewater, the troubles posed on environment with their disposal, treatment technologies available and the role of textile industries on nations economy etc.

The following section describes the process flow sheet available at OCM Pvt.Ltd. Amritsar, the work place of my project internship.

2.5 Process flow sheet of Effluent treatment plant at OCM Pvt. Ltd.

OCM Pvt. Ltd. is majorly involved in producing textiles such as woolen tweeds, suiting and shirting. The process flow chart of ETP units along-with brief explanation of each unit is shown below.

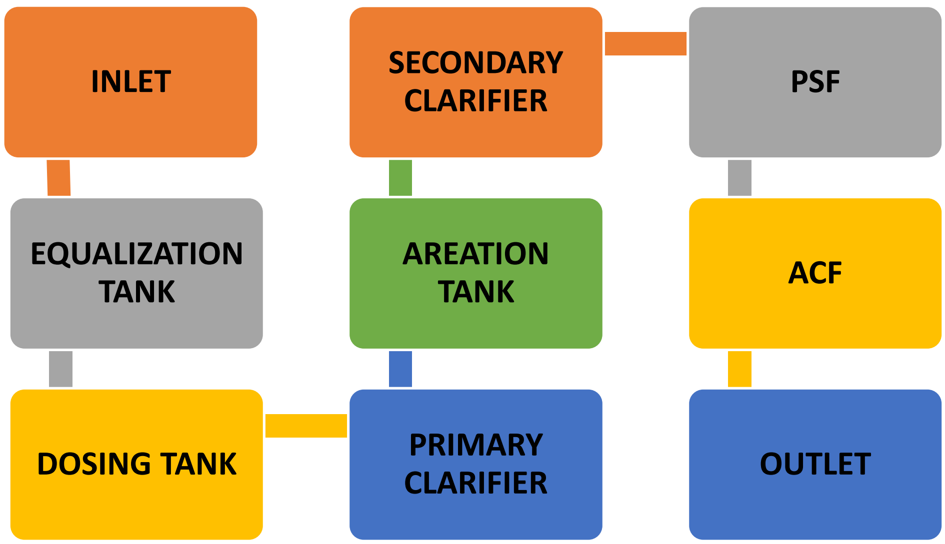

Figure 2.5 : ETP Units

The plant comprises of the following unit operations:

Raw Water Pumping: Two effluent lines are routed to the plant from the factory premises.

Inlet screening: A bar screening is feted before equalization tank to remove big particles and debris.

Equalization cum Aeration Tank: Equalization cum aeration tank is used in ETP to overcome the problem of flow, pH and colour fluctuations.

Pretreatment pumping: Two pumps are installed in equalization tank from where effluent pumped to the flash mixing tank.

Flash Mixing tank: Flash mixing tank is used to mix dosing chemical with effluent. Chemical is mixed with the help of agitator. Poly aluminium chloride, Poly electrolyte and Lime are dosed in the flash mixing tank.

Primary Clarifier: After mixing of chemical, effluent is passed through Primary Clarifier from flash mixing tank by gravity flow. Primary clarifier is used to remove solid particles before biological treatment. Effluents enters the clarifier tank and settleable solids (sludge) settles down to the bottom and is removed via sludge removal system.

Sludge Removal System: A rack with gear is installed in the primary clarifier to push settled sludge in the middle of V shape bottom of clarifier and a pump is used to carry out sludge from system.

Collection Tank: After Primary clarifier effluent is collected in two No.s of collection tank from where effluent is pumped to the aeration tank. Collection tank is used to avoid the dry running problem of pump.

Forward feed pumping: A forward feed pump is installed to carry effluent from collection tank and pump it to aeration tank.

Aeration Tank: Aeration is used to provide oxygen to the microorganisms to degrade the organic waste. It is also provided in the equalization tank to reduce oxygen demands. Air is introduced to the tank through blower (to supply air), diffuser (to diffuse the air uniformly). One blower is used to supply oxygen (air) during the treatment process. If the blower malfunctions a spare blower is provided to overcome this problem. A blower is provided for equalization tank also. Dissolved oxygen is an important parameter in aeration tank which is checked time to time for sufficient oxygen availability for effective treatment.

Urea, DAP and Mollases is used in aeration tank to maintain nutrient level for bacteria. The mix liquor from aeration tank exits to the secondary clarifier tank by overflowing on baffle assembly.

Flocculent dosing: A low concentration flocculent is dosed in the outlet pipe of aeration tank for better settling of sludge in secondary clarifier.

Secondary Clarifier: A secondary clarifier tank is used to settle down the mix liquor suspended solid. The tank is equipped with diffusion drum, central drive scrapper baffle chamber and sludge removing system.

Return/ Excess Sludge System: A sludge pump is used to carry out sludge from secondary clarifier and pump to aeration tank to maintain microorganism population in the aeration tank. Another line with valve is also provided to divert excess sludge into sludge thickening tank.

Chlorination Tank: After secondary clarifier treated water moves to chlorination tank. In this tank chlorine is used for disinfection.

Filters: Three set filters is used to filter treated water (One running at a time). Every set have two filters first is Pressure Sand Filter and second is activated carbon filter. Treated water is first sent to PSF and Then to ACF to remove color and odor.

Sampling: A sampling point is provided to take sample of final discharge water for analysis.

Chapter 3: Materials and Methods

3.1 **Chemicals and reagents** : Chemicals used in the experiments were purchased from approved suppliers and all reagents prepared were maintained under safe conditions of time and temperature etc.

3.2 **Laboratory equipment**: The equipment such as incubators, digesters, weighing balances calibrated regularly, maintained for approved accuracy was utilized during study period.

3.3. **Sampling points and frequency**: Influent was collected before the liquid entering the equalization tank and effluent from a point leaving the activated carbon filter unit. Representative samples were collected twice at weekly intervals during the study period Dec2024-May2025.

3.4 **Quality parameters analysed**: Influent and effluent were analysed for physical parameters such colour, temperature, TDS and TSS and Chemical parameters such as pH, D.O, BOD, COD etc.,

3.5 **Environmental Procedures**: Procedures adopted for estimation of quality parameters were as per Standard methods for examination of water and wastewater APHA, 24th edition.2025.

Procedures

Temperature: Using Direct Measurement Methods and a thermometer is used to measure the temperature of the inlet and output water.

Total, dissolved and suspended solids: Gravimetric technique for measuring total solids from unfiltered, dissolved solids from filtered sample was used. Suspended solids was calculated as difference between total and dissolved solids.

pH: Electrometric method of pH was used with pH meter. The meter was calibrated prior to measuring pH for unknown samples.

Dissolved Oxygen: DO is one of the most significant markers of water quality. The standard code is.3025.38.1989 was used for DO analysis.

Biochmical oxygen demand: The procedure for DO fixation in the samples for 0 day and 5th day was done and 5-dayBOD was calculated using the formula

$$\textbf{BOD = D.F} \ [(DO_{ib} - DO_{fb}) - (DO_{is} - DO_{fs})]$$

DO_{ib}= Initial DO of blank

DO_{fb}= Final DO of blank

DO_{is}= Initial DO of sample

DO_{fs}= Final DO of sample

Chemical Oxygen demand: The standard code 3025.58.2006 was followed for COD analysis. The procedure included the digestion of sample. 10 ml sample, 5ml of potassium dichromate and 15 ml of COD reagent was taken as a complete 30 ml sample to be digested for 2 hours. After 2 hours the digested sample was cooled and then 3-4 drops of ferroin indicator were added. The sample was then titrated against ferrous ammonium sulphate that gave the end point of a sharp blue green to reddish brown.

COD value was calculated using the below mentioned formula:-

$$\textbf{COD} = [(A-B) \times M \times 8000)/V_{sample})]$$

Chapter 4: Results and Discussions

Having discussed about the influent and effluent quality parameters, frequency and analysis procedures in previous chapter, the results obtained, discussions and support from the literature the results achieved are presented in the present **chapter 4.**

The OCM Pvt; Ltd works in 3 shifts A, B and C. The influent and effluent quality was analyzed for shift A by collecting samples twice a week during the study period. The existing parameters were also compared to standards (Table 4.1) as defined by PPCB

Parameter	PPCB Standard
Temperature	Not exceeding 40 ˚C
pH	6.5 – 8.5
DO	2 mg/l to 8 mg/l
BOD	30 mg/l
COD	250 mg/l
TDS	2100 mg/l

Table 4.1: PPCB Standard values for disposal of treated effluent

4.1 VARIATIONS IN PHYSICAL PARAMETERS

The section 4.1 shows the variations of colour, temperature and dissolved solids in the influent and effluent at the inlet and outlet of the treatment plant.

4.1.a Colour Analysis

Throughout study, the colour in the effluent released was transparent and in the influent was blue (results not shown).The blue colour could be due to the chemicals and dye stuffs used in the dye house.

Fig 4.1.a Sample of Inlet

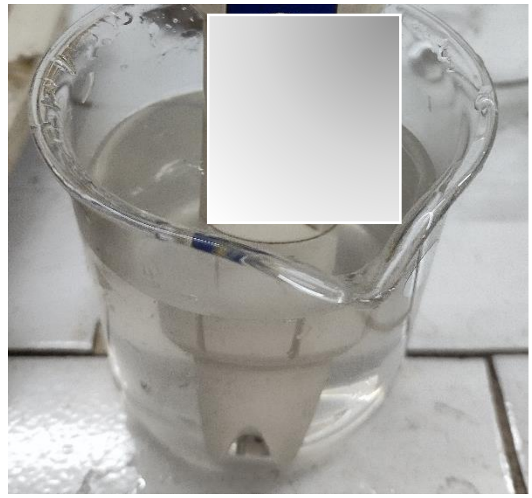

Fig 4.2.b Sample of outlet

Colour is measured on Pt-Co scale and may be apparent and true colour. Depending on the industrial activity, the colour varies. The effluent from paper mill is brown. Electroplating is yellow, and slaughter house is red etc. Colour caused by some dyes prove to be toxic to aquatics and interfere with light transmission etc.

4.1.b Temperature Analysis

Figure 4.1 displays the mean temperature (deg C) range for the influent, which is 31.45 ± 0.59 to 36.22 ± 1.89, and the mean temperature range for the effluent, which is 32.49 ± 0.58 to 32.57 ± 0.67, in relation to the PPCB standard of 40^0C. In the study, the highest recorded average temperature in the influent was 38.01 °C in month May 2025 and the lowest recorded temperature was 31.03 °C in month December 2024. Conversely, the highest recorded average temperature at the outlet was 33.34°C in month May2025 and the lowest was 32.06 °C in month January 2025. When the totality of the observed data is compared, the temperature falls within the acceptable range of the PPCB norm, which is not exceeding 40 °C.

Temperature is an important physical property. It decides the dissolved oxygen present, health status of aquatic fish, settleability of solids, rate of biological activity and process efficiency etc., In general, Thermal power plants are often associated with release of heated waters above 60 deg C. Mesophilic temperature range 25-30 deg C are found suitable for biological treatment.

Crystal violet and brilliant green dyes were used to eliminate malachite green from bacterial cultures and variables such as temperature, colour were optimized by Adane et.al,2021.

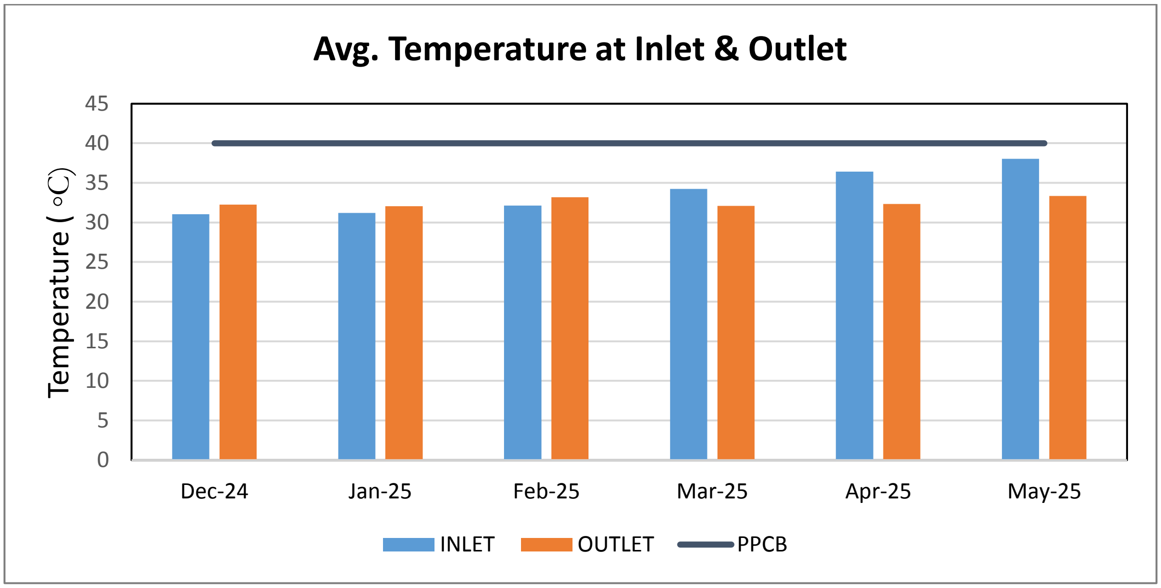

Figure 4.1: Temperature Correction

4.1.c TDS Analysis

In comparison to the PPCB standard of 2100 mg/l, which is displayed in figure 4.2, the graph displays, the mean value range of the influent from 2165.5 ± 152.23 to 3074 ± 639.33 and the mean value range at the outlet from 1757.66 ± 37.54 to 1933 ± 76.07.

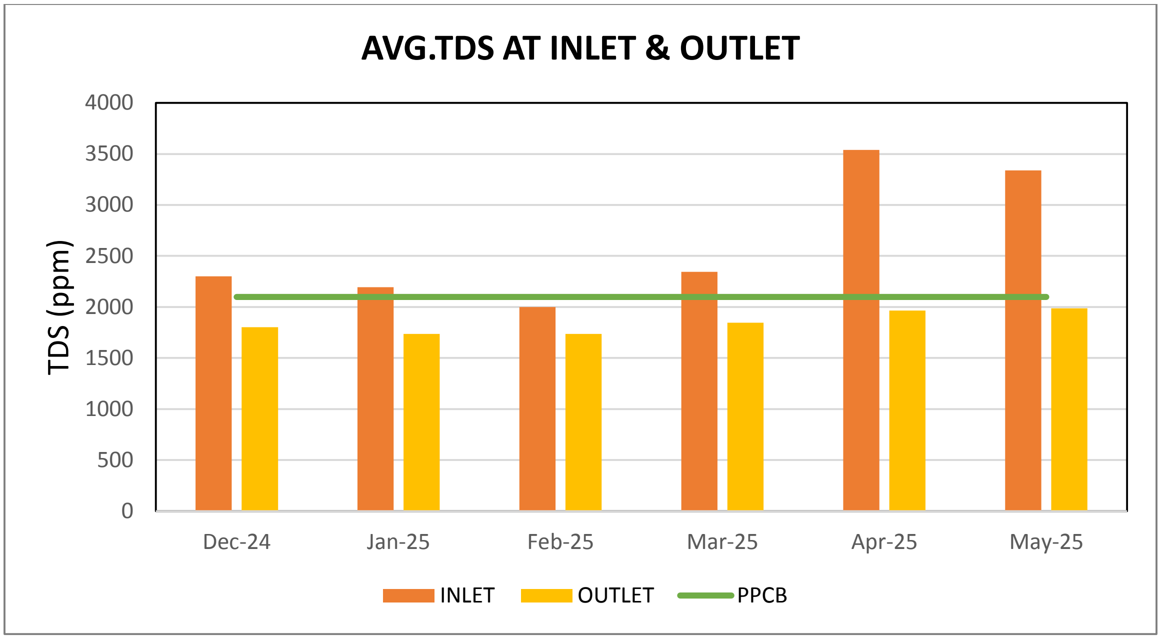

Figure 4.2: TDS Correction

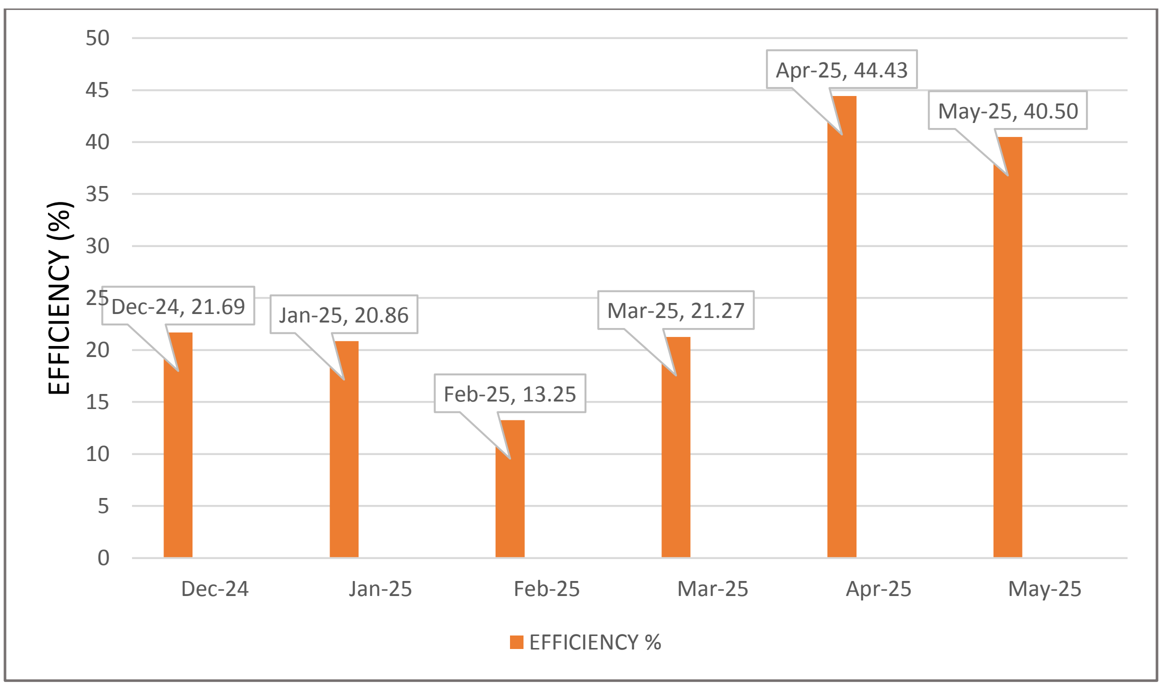

Figure 4.3: TDS removal Efficiency

As shown in Figures 4.2 and 4.3, the lowest value of TDS at the inlet was 2000 mg/l in February 2025, and the highest mean was 3538 mg/l in month April 2025. However, the lowest value of TDS in the treated effluent was 1735 mg/l in February 2025, and the highest average was 1987 mg/l in month May 2025. The TDS falls within the appropriate range of the PPCB requirement of 2100 mg/l during 6 months of data analysis. February 2025 had the lowest percentage of removal efficiency (13.25%), whereas May 2025 had the highest percentage of removal efficiency (40.50%).

The variations in the efficiency is probably due to temperature of February (32 deg C) and May (38 deg C).

TDS is contributed by salts, dyes etc. used in textile operation and are related to hardness, corrosion and boiler troubles at the industry, this increases the treatment cost of desalination, ion exchange, dialysis etc. High TDS effluent is not suitable for irrigation.

Brown and Sheedy, 2002 report on desalination efficiencies and L and 2016 working on fresh water and oceanic water focusing on TDS are available.

4.2 VARIATIONS IN CHEMICAL PARAMETERS

The section 4.2 shows the variations of pH, DO, BOD and CODin the influent and effluent at the inlet and outlet of the treatment plant

4.2.a Analysis of pH

In contrast to the PPCB standard of pH of treated effluent from 6.5 to 8.5, which is displayed in Figure 4.4, the graph displays the mean value range of pH for the influent from 6.98 ± 0.15 to 7.56 ± 0.28 and the mean value range of the effluent from 7.15 ± 0.04 to 7.68 ± 0.06. Figure 4.4 also illustrates how the entering wastewater's high alkalinity results in an exceptionally high pH of the raw effluent. The method's bleaching agents are the cause of the wastewater's high alkalinity. With the help of HCl, the pH correction is completed, bringing the pH all the way down to neutral, which is ideal for biological treatment.

March 2025 reported the highest normal pH value at the inlet at 7.82, while April 2025 showed the lowest value at 6.81. The outlet's maximum pH value was 7.75 in May 2025 and its lowest value was 7.12 in March 2025, both of which were within the standards.

pH is measurement of hydrogen ion intensity and it affects the biological systems. Ideally, neutral pH is desirable. With acidic/alkaline effluent , neutralization is performed.

The pH, salt content, and temperature of wastewater all affect how stable the ozonation process is. Chemical coagulation, softening are quite dependent on pH of the system (Agarwal and Singh,2022)

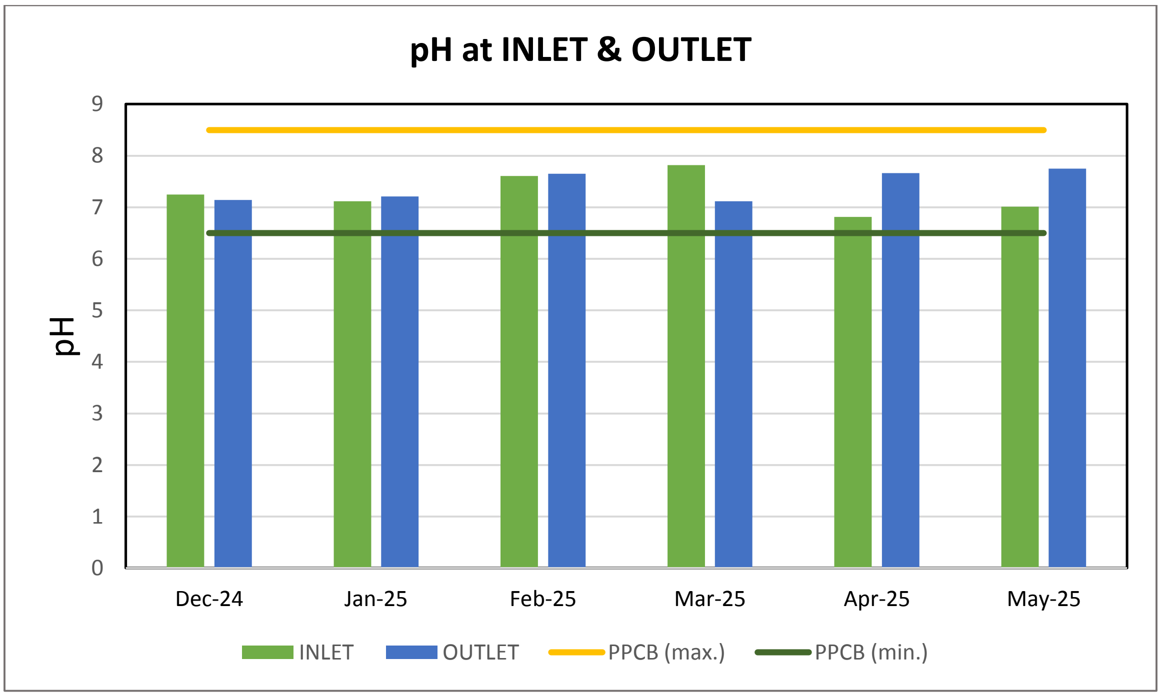

Figure 4.4: pH Correction

4.2.b Analysis of DO

In contrast to the DO standard value of 2 to 8 mg/l which is displayed in Figure 4.5, the graph displays the mean value range of DO at the inlet from 0.7 ± 0.1 mg/l to 0.8 ± 0.1 mg/l and the mean value range at the outlet from 2.2 ± 0.2 mg/l to 2.6 ± 0.2 mg/l. Figure 4.5 shows that the lowest value of liquidate in the inlet was 0.6 mg/l in March 2025. However, the lowest value was 2 mg/l and the highest average of liquidate in the outflow was 2.8 mg/l. Following six months of data analysis in accordance with the observed values, the DO value falls between 2 to 8 mg/l, which is the appropriate range of PPCB standard.

DO is the major parameter in water and wastewater. DO levels are affected by temperature, turbulence, altitude etc., DO affects the health of aquatic fish and ease/difficulty to biodegrade aerobically. DO is contributed by algal growth during treatment. Wastewater is aerated by mechanical aerators or diffuser systems. Aerobic systems are faster and safer in comparison to anaerobic systems.

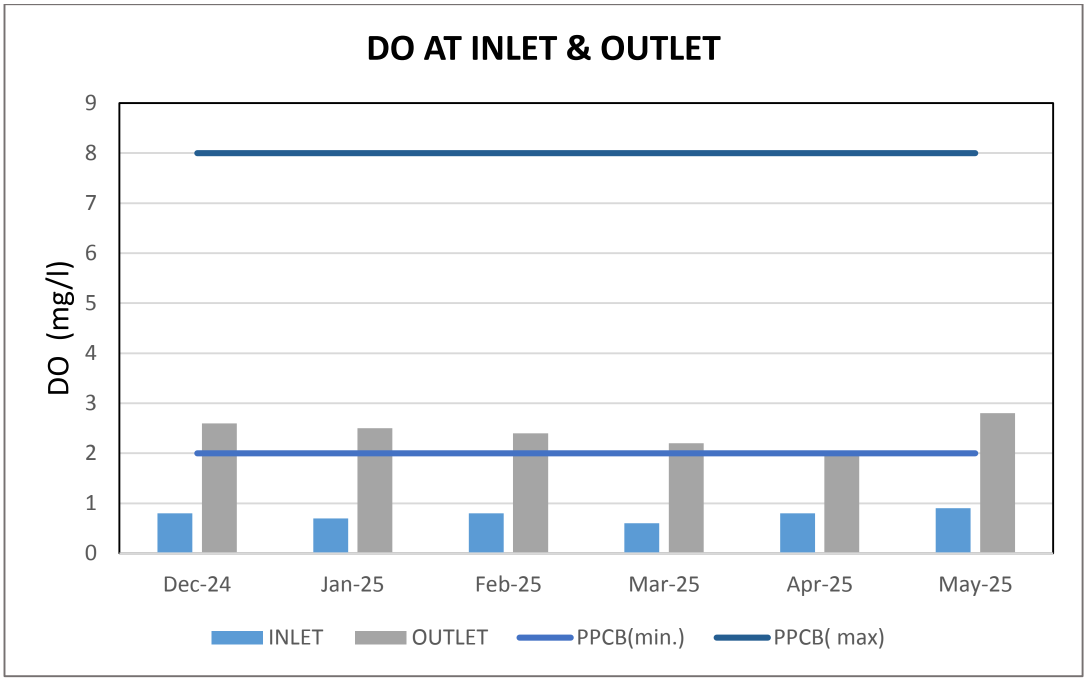

Figure 4.5: DO Correction

4.2.c Analysis of BOD

As compared to the PPCB standard of 30 mg/l for BOD in treated effluent in figures 4.6 & 4.7, the graph displays the mean value range at the inlet from 43.33 ± 17.55 to 66 ± 5.56 and the mean value range at the outlet from 11.67 ± 1.53 to 16.33 ± 1.53. The highest mean BOD value at the inlet was 72 mg/l in April 2025 and the lowest was 45 mg/l in February 2025. However, over six months of data analysis, the outlet's highest mean BOD was 18 mg/l in April 2025 and 10 mg/l in May 2025, which were within the permitted of 30 mg/l.

The BOD removal efficiency (Fig 4.7) remained almost constant throughout the months. However during the study, the lowest percentage removal efficiency was 66.44 % in February 2025 and the maximum percentage removal efficiency was 83.33 % in May 2025.

BOD is an indicator of pollution strength of wastewater and measurement is done by dilution method. The test has many advantages and an error of +/- 10% is allowable. Treatment technologies focus on reducing BOD and make the effluent suitable for disposal into water body or onto land. Madhav et.al (2018) discuss BOD as indicator for textile effluent disposal into various media.

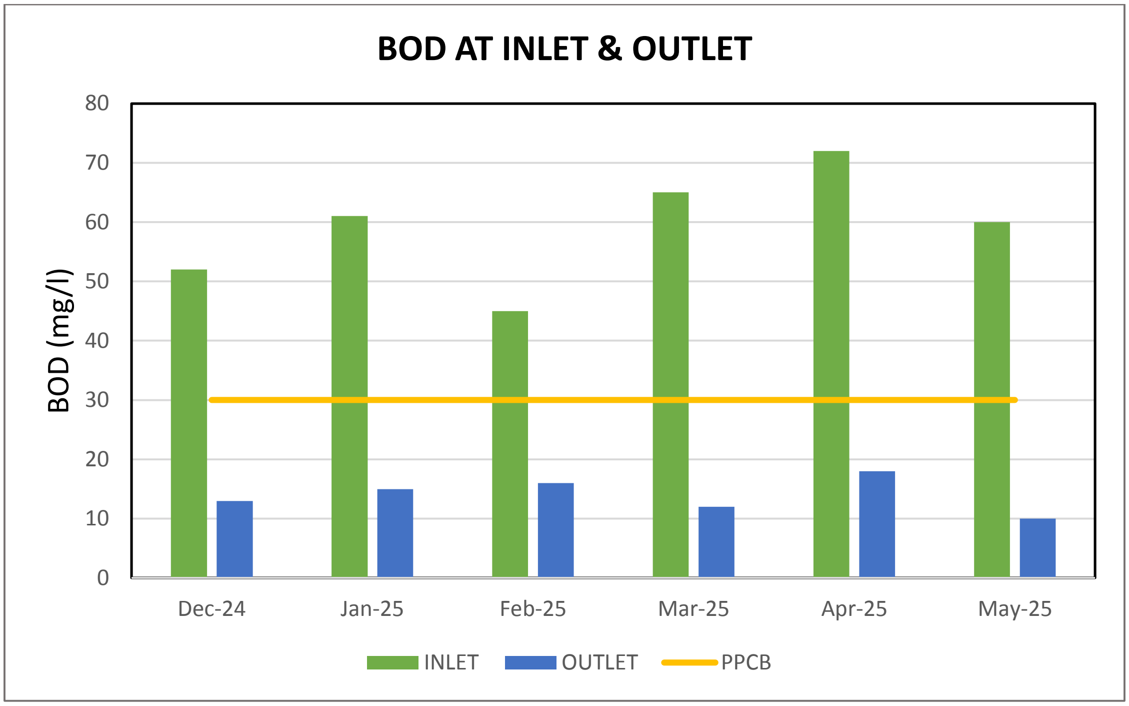

Figure 4.6: BOD Correction

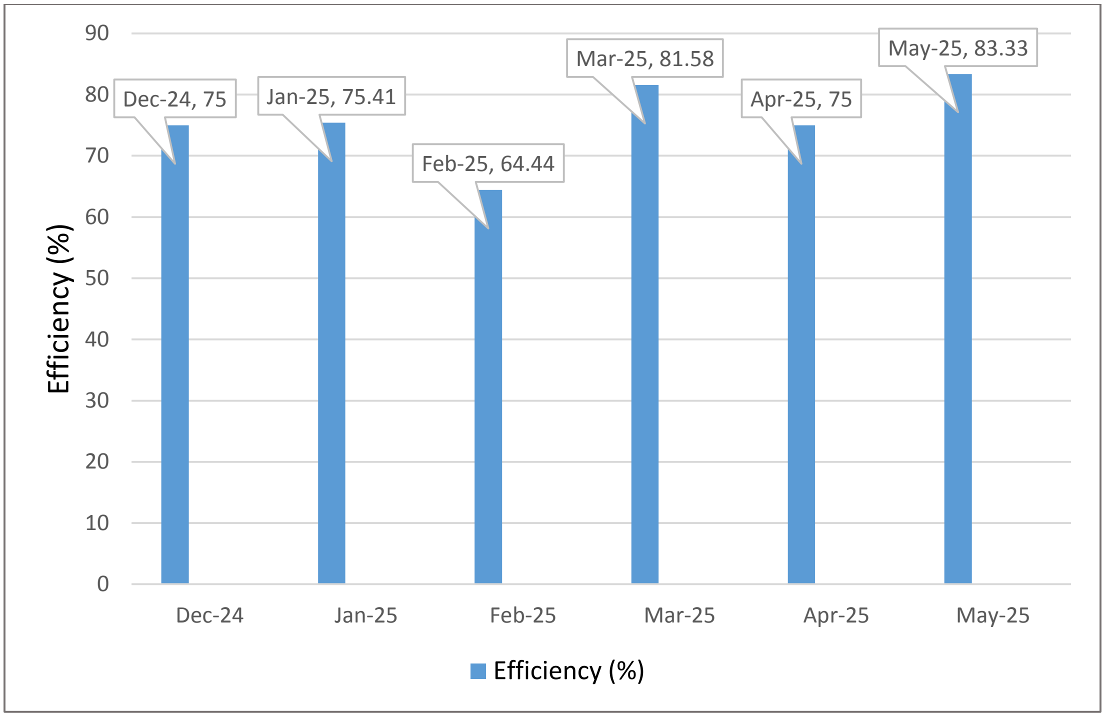

Figure 4.7: BOD Removal Efficiency

4.2.d Analysis of COD

The mean value range for the influent is depicted as 520 ± 138.56 to 628.33 ± 20.21 while the mean value range for the effluent as 130 ± 43.58 to 180 ± 10, in comparison to the PPCB standard of 250 mg/l in figure 4.8. Figures 4.8 and figure 4.9 demonstrate that the mean highest COD value at the inlet was 650 mg/l in February 2025 whereas the lowest value was 360 mg/l in April 2025. However, during six months of data analysis, the mean maximum value of COD at the outlet was 190 mg/l in February 2025. The COD values found were within the criterion of 250 mg/l. From the figure 4.9 it is noted, the lowest removal efficiency of COD was 70.77 % in February 2025 and the maximum was 77.78 % in April 2025.

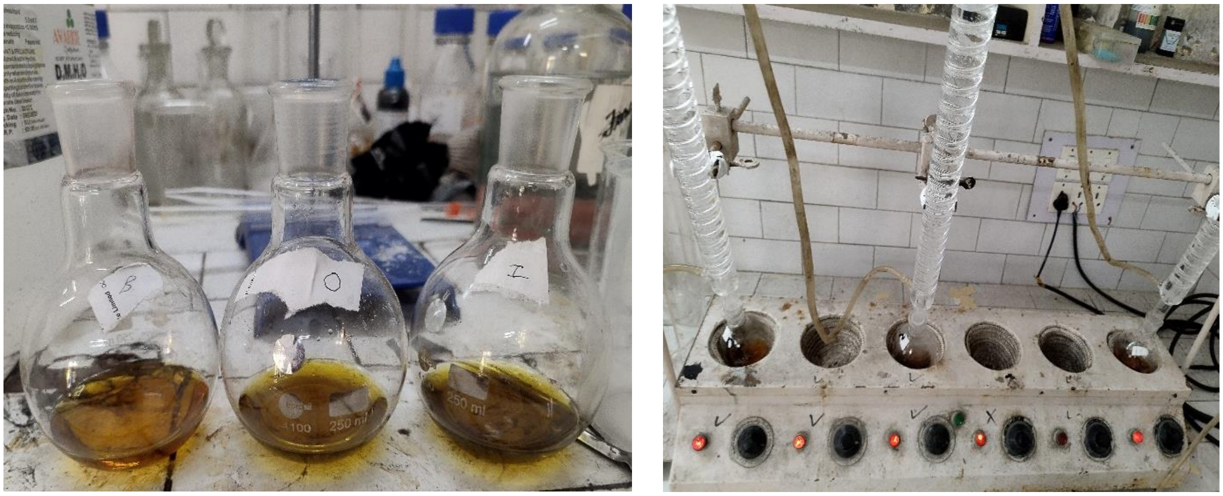

Figure 4.2.1 COD Apparatus

COD as pollution strength measures the degradable organics speedily and is limitation free. COD often is substituted for BOD. Padalkar and kumar,2028 have included COD for assessing **reliability** of common effluent treatment plants.

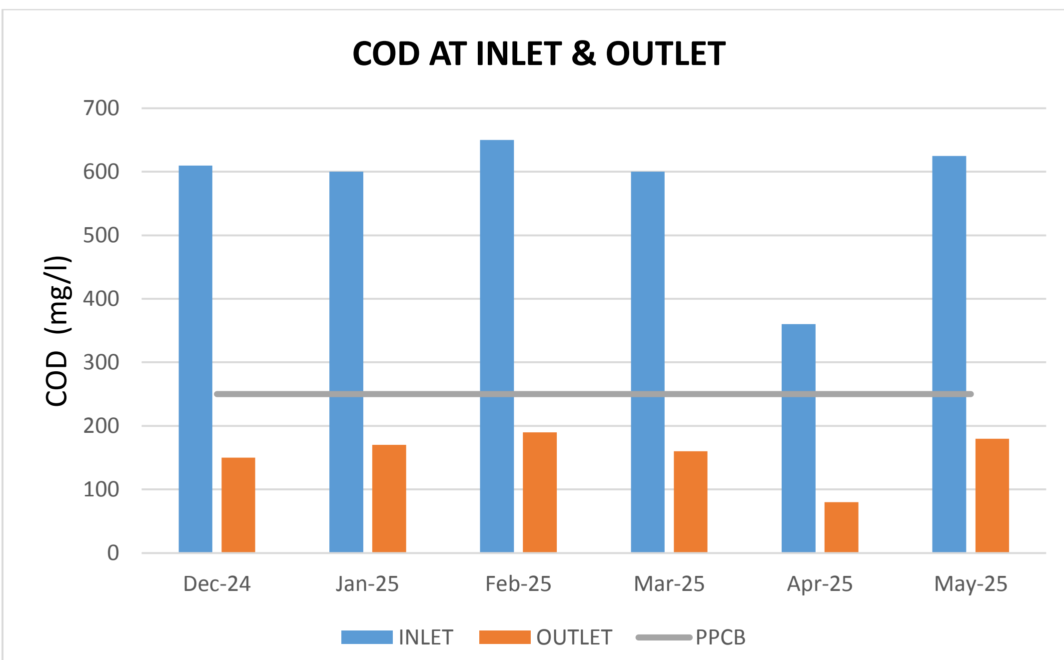

Figure 4.8: COD Correction

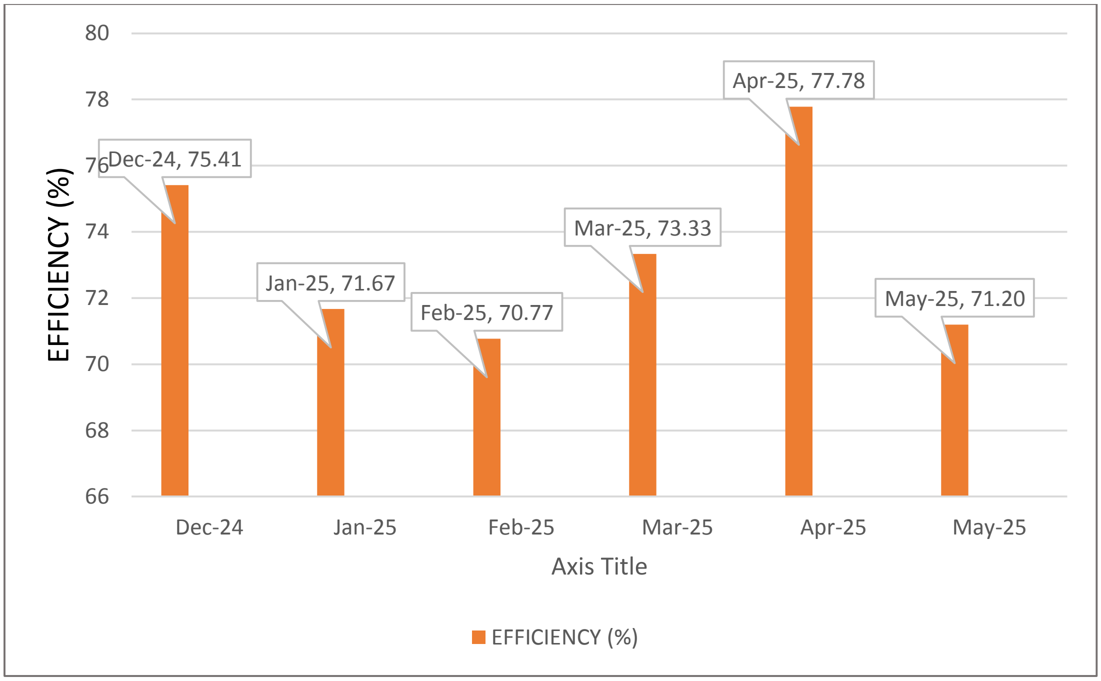

Figure 4.9: COD Removal Efficiency

4.3 TDS reduction by Dilution Approach

Among the pollution parameters of concern from disposal point of view, TDS are found high in comparison to other parameters (Personal Communication by Head-Operation. 2025). TDS is majorly contributed by the softener plant. A technique of dilution was tried to reduce TDS of backwash by mixing with effluent generated at the treatment plant. Temperature, pH of the mixture at various dilutions were also noted down and the results are included in **Table 4.2.**

S. No.	Temperature	Softener plant (Backwash Sample in ml)	ETP effluent Sample (from factory premises)	TDS (ppm)	pH
1	31.6 ˚C	90	10	7230	6.5

2	31.9 ˚C	80	20	7550	6.7
3	32.5 ˚C	70	30	6850	7
4	32.4 ˚C	60	40	7120	7
5	32.2 ˚C	50	50	5560	6.5
6	31.6 ˚C	40	60	5260	7
7	31.7 ˚C	30	70	3870	6.5
8	31.7 ˚C	20	80	3070	6.5
9	31.8 ˚C	10	90	2660	7
10	31.8 ˚C	5	95	2250	7

Table 4.2: Results of Dilution Approach

It is observed, a dilution of softener plant backwash water and ETP's effluent at 10% or more is essential to lower TDS value to an acceptable value of 2100mg/l. pH and temperature at this dilutions were also observed within the acceptability.

Several techniques such as ultra filtration, microfiltration, dialysis, adsorption are reported in the literature by authors Adhikary ett. Al,1991.

4.4 Overview of the Analysis results

Physical parameters (Colour, temperature and Dissolved solids) and chemical parameters (pH, dissolved oxygen, BOD, COD) were measured in the influent and effluent of OCM Pvt. Ltd. Although 15-20 characteristics are defined in the wastewater, only those having more concern from disposal point of view of PPCB were included in the study. Representative samples were collected and parameters were analysed by standard procedures in the laboratory established.. Inspite of working of the industry in 3 shifts, the analysis was confined to samples generated in first shift. Obtained analysis results were also compared from time to time with online continuous sensor data generated at the industry. COD to BOD ratio obtained as large as 10 clearly indicates difficulty to biodegrade the present effluent.

Chapter 5: Conclusions

Based on the study done, work elements defined, methods followed and results achieved the following conclusions are drawn.

1) Manufacturing process involved and scheme of treatment plant existing at OCM Ltd. for effluents were understood (included in seminar report).

2) The software NOW used at the industry for purchase, handling sales,, warehouse modules was learnt thoroughly (included in minor research report).

3) The color of the influent is measured to be blue and the color of the effluent is colorless (transparent white). The temperature within the inlet varied from 43.82 °C to 46.91 °C and outlet was 32.3 °C to 34.5 °C.

4) pH, temperature, dissolved oxygen, BOD and COD results in the effluent indicate the values within the accepted standards of PPCB.

5) The TDS values at high concentration is a major concern from disposal point of view. Dilution of softener backwash water effluent at more than 10% is essential to reduce TDS to limits.

Future Work Plan

1) OCM Pvt. Ltd, Amritsar is operated in 3 shifts A, B and C daily for textile production and effluent treatment. Hence for consistent treatment efficiency of effluent, collection and analysis at all the shifts is necessary. How ever, the data collection and analysis pertains to a single shift A. The Work on analysing the effluent data generated from all shifts may be carried out.
2) Plotting treatment kinetics, evaluating techno economics and redesign of treatment scheme may be tried.

Chapter 6: Impediments faced during project internship

OCM Pvt. Ltd, Amritsar in the recent times has shifted from manual testing of effluent quality in the laboratory to online/continuous monitoring and submitting the data collected to Punjab pollution control board.

This has resulted in non-purchase of equipment such as Jar test, COD reflux apparatus, Kjeldahl assembly etc. The essential units such as BOD incubator was found irregular/mal functioning most of the times. Use of expired chemicals, long duration for repairs and purchase were very commonly noticed at the industry.

In spite of the above difficulties, online monitoring and collection of effluent quality data has paved the way for completion of internship at stipulated time.

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