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Evaluative Method and Performance Analysis of Water Treatment Plant

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Abstract: The effectiveness of water treatment plants (WTPs) and their individual components in achieving safe drinking water standards must be assessed. The study's goal is to assess how successfully the WTP in Nangloi, West Delhi, is doing its job. Some of the physiochemical variables used to measure efficiency are turbidity, total solids, temperature, and total dissolved solids. water loss, pH, dissolved solids, DO, DO, pH, and RC are all parameters that should be monitored. Every hour, six random samples were obtained across the city and examined in compliance with the most up-to-date IS:10500 guidelines for safe drinking water. They were the inlet chamber, the discharge from the four primary clarifier, and the filtration unit. Given that this WTP draws water from a sea water source, it is to be anticipated that all water quality indicators, with the exception of turbidity and microbial levels, are within criteria for the drinking water. The ultimate turbidity of the water is routinely measured to be less than 1NTU, the threshold for unacceptable levels. Any leftover germs are eliminated by the 1.5 ppm of chloride present in the final product. Just 0.36 percent of the water goes down the drain throughout the treatment procedure. The studies show that the treated wastewater is suitable for human intake since it conforms, on average, to the drinking water standards specified by IS:10500. This study will aid in determining the efficiency and location of underperforming units, which will improve water quality at no extra cost..

Keywords: Water Treatment Plant, Performance evaluation, Water Quality Parameters, Grab Sampling, Water quality Standard

Introduction

Water is the most precious resource since just 1% of all water on Earth may be used for human use. Access to potable water that can be relied upon It is impossible to exaggerate the significance of access to safe drinking water to the health and prosperity of a country. Although though regulations for potable water supply have become more stringent over time, the purification method has remained same. The whole treatment facility was built to conform to the most latest guidelines for safe drinking water. To guarantee that they can generate drinkable water in accordance with current requirements, water treatment plants (WTPs) and their component units must undergo rigorous testing. Only by isolating specific issues can WTP be optimized for optimal performance, which in turn leads to improved water quality, decreased operational costs, decreased water waste, etc.

A treatment plant's effectiveness is measured in accordance with a predetermined set of criteria, such as the quantity of pollutants eliminated (in terms of turbidity, color, suspended particles, etc.). Although developed countries have developed a comprehensive performance

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assessment mechanism, developing countries like India lack access to equivalent resources. In the same manner, issues with production plant are found and addressed, guaranteeing the facility runs smoothly. Performance Review programs or studies may help improve water quality at no extra cost.

According to a survey conducted by the World Health Organization in 2007, more than 1.1 billion people do not have access to an improved water supply. More than 71% of India's agriculture is under-irrigated. The pollution of aquatic ecosystems by industrial effluent is a serious problem. Our country often has water shortages in the summer due to low river and groundwater, and a large proportion of treated water is wasted as sewage water after being utilized for residential purposes in urban areas. In highly populated areas, the need for clean water skyrockets during the warmer summer months. Thus, it is crucial to treat wastewater..

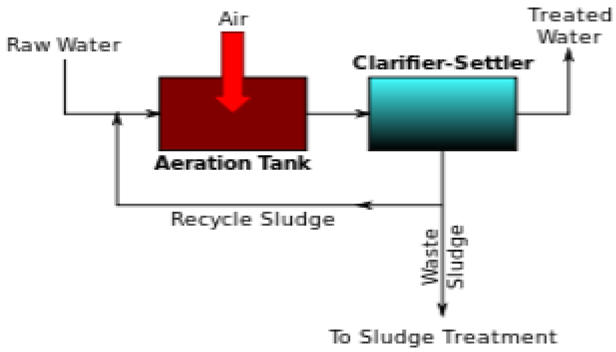

Figure.1 Two stage ASP process

Microorganisms get the majority of the carbon they need from carbohydrates, especially polysaccharides. Lipids, hydrocarbons like methanol, and proteins are only some of the various materials that find use. Cellulose is favored by fungi. Nitrogen in the atmosphere is inert and unavailable to microbes due to chemical interactions. Examples of nitrogen-containing compounds that are often utilized as sources include amino acids, ammonium, nucleotide, uric acid, and urea. Natural compounds containing sulfur are abundant. Amino acids are produced by reducing inorganic sulfates with sulfide. Some microorganisms may get the sulfur they require by decomposing hydrogen sulfide. Organic sulfur is another potential supply of the element.

A mixed liquor is a kind of wastewater in which biological materials have also been included. Surplus mixed liquor is dumped into settling tanks after wastewater has been thoroughly treated in an activated sludge plant, while the treated supernatant is stored for later use. Some of the settled material, known as the sludge, is transferred to the head of the aerobic process to re-seed the new wastewater entering the tank. In this context, the term "return activated sludge" is used to describe the floc (RAS.). The scientific term for too much sludge is waste activated sludge (WAS). WAS is removed from the treatment process and digested, either anaerobically or aerobically, to keep the wastewater's biomass to food ratio stable.

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Chemical oxidation technologies employ oxidizing agents to degrade or convert complex harmful molecules into simpler innocuous ones. The Advanced 4 Oxidation Procedure (AOP) utilizes the generation and use of hydroxyl radicals to oxidize hazardous compounds that are extremely difficult to oxidize using more conventional techniques. Furthermore, the AOP disinfection method is quite efficient (about 99.9%). It not only kills germs, but it also neutralizes any noxious odors or flavors. Advanced oxidation methods are a catch-all phrase for a range of chemical treatment treatments that employ oxidation through interactions with hydroxyl radicals (•OH) to remove organic and sometimes inorganic contaminants from water and waste water. Nevertheless, in practical wastewater treatment situations, this term often describes a portion of these kind of chemical treatment that use ozone (O3), peroxide (H2O2), and/or UV light. The focus of the present study is on hydrogen peroxide and ultraviolet light.

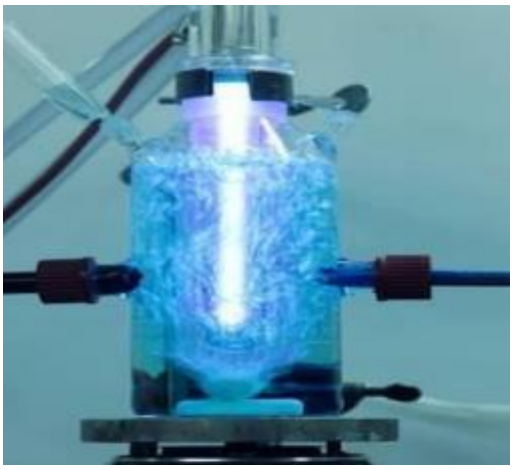

Figure.2 UV- H2O2 advanced oxidation process

This approach is superior as it turns H2O2 into safe water. Thus, oxidation is absolutely safe as indicated. If hazardous bacteria are present, their nucleic acid will be damaged by the UV light, resulting in a greater degree of disinfection. Our suggested plant structure comprises ASP functioning as a second water treatment procedure and AOP as both a tertiary one. Both the first and second phases of treatment of water were performed out in the same manner that water is generally treated in affluent nations. Usage of treated water is conceivable since water may be employed for drinking if authorized, or for irrigation or regular home uses. In addition to decreasing the cost of producing process water and minimizing the threat of water contamination, processed water may be employed as process water in companies. It may be advantageous in metropolitan settings to treat an amount of moisture at once.

Literature Review

Tinku Casper D'Silva et.al. (2021) The study compares and contrasts the efficacy of 36 unique STPs. Moving-bed biofilters (MBBRs), sequencing batch reactors (SBRs), waste stabilization ponds (WSPs), upflow anaerobic sludge blanket reactors (UASBs), extended aeration (EA), surface aeration (SA), and polishing ponds were used to construct STPs with procedure capacities ranging from 3 million L per day to 40 million L per day. According to

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the findings of a gray relational analysis that compared the STPs' efficacy in eliminating pollutants, the best systems were SBR systems, followed by UASBs equipped with EA, and then MBBRs, UASBs equipped with different posttreatment options, and WSPs, in that order. Fuzzy analytic hierarchy process then preference ranking organization method for enrichment evaluation were used as part of a multiple-criteria decision-making (MCDM) approach to evaluate the most prominent wastewater treatment technologies with respect to three sustainability criteria: environmental, financial, and technical (PROMETHEE). Because to its fewer emissions of greenhouse gases, energy consumption, sludge production, and resources and energy recovery characteristics, the UASB + EA strategy came out on top in the MCDM analysis, followed by the SBR. The MCDM results for the interactive support method were verified using geometric analysis. According to the findings of this study, although using an anaerobic process, microaerobic technologies have the potential to attain disposal requirements that are almost on par with those obtained by intensive aerobic technology.

Shima Rajabi et.al. (2020) Compost leachate, among the most harmful wastewaters, is found in unexpectedly large amounts. This research was conducted in a compost manufacturing plant that had the capability of processing 200 t/day of municipal solid waste, and its major objective was to examine the treatment process of compost effluent in a vertical flow hybrid anaerobic reactor. The hybrid anaerobic reactor's experimental data has been used to test and compare many kinetics-based models. Umax, the highest achievable rate, was computed to be 21.72 days-1 when the substrate clearance rate (k2(s)) was used.

Sahar Saghafi et.al., (2020) Conservation of energy in industrial water treatment plants (IWTPs) is crucially important because of global warming, fossil fuel scarcity, and high energy costs. In this study, we looked at how changing a few variables affected the EEI of 79 IWTPs spread over the country of Iran. With the use of data envelopment analysis, each IWTP was assigned an efficacy score between 0 and 1. (DEA). Maximum potential savings in the use of energy and carbon carbon pollution were determined. Just 2.6% of IWTPs had an EEI more than 0.7, while 73.4% had inefficient energy use and an EEI of less than 0.3. Age and size of the sewage treatment facility, COD removal, system which handles, pumping station, and aeration method all had an impact on EEI, power consumption, and CO2 emissions. By boosting EEI in IWTPs, it is expected that annual energy expenses will be cut by 72.9% and CO2 emissions would be cut by around 52.8 t. IWTPs throughout the world should all work to increase their EEI in order to reduce energy costs and carbon dioxide emissions. The results may improve energy management at IWTPs**.**

Jianglei Xiong et.al., (2020) The Combined Conventional Biological Anaerobic Digestion Model (CASADM) was used to model a full-scale Cannibal wastewater treatment plant, and the results indicated a low net sludge yield of approximately 0.21 g volatile hanging total solid chemical oxygen demand (g VSS/g COD) removed after 2 years of operation. CASADM gave an accurate description of the information that was available for each tank in terms of industrial effluent and made by mixing volatile suspended solids (MLVSS) concentrations. Modeling helped shed light on the factors that contributed to low net sludge generation at this Wastewater facility. Due to substantial net decay or slow growth [negative or very high values of solids retention times (SRTs)], the system only converted around 28%

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of the whole input COD to Hydrogen, and total active biomass was really only 13%-21% of the MLVSS. It was shown that net degradation or developmental delay of active biomass caused by high CH4 generation and intake of active biomass resulted in a small quantity of net sludge output.

D. D. Mohite et.al., (2019) The effectiveness of anaerobic treatment of water with a chemical aerobic metabolism (COD) of 110,000-140,000 mg/L and a BOD of 55,000-65,000 mg/L was investigated using a large areas stirred-tank reactor (CSTR).

Modelling of Waste Water Treatment Plant

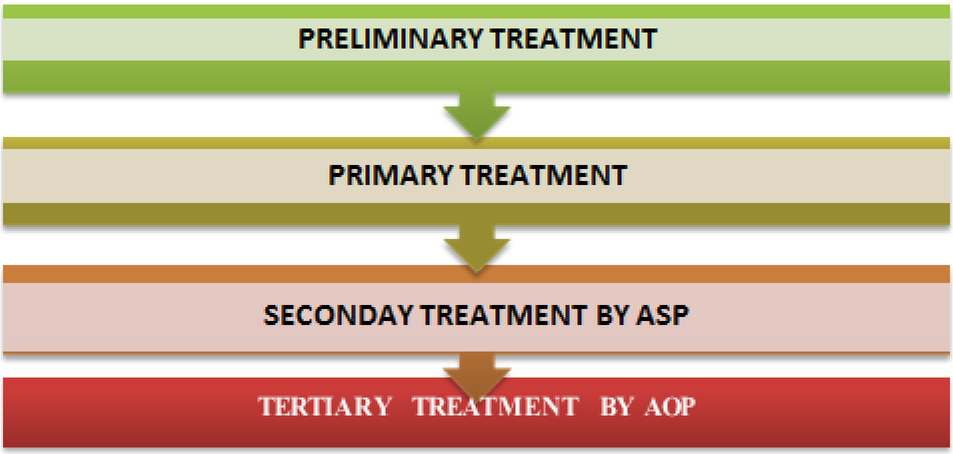

Figure.3 Steps for treatment process

First, sedimentation of large particles took place in a cylindrical tank. A screen screen was set up to stop particles larger than a specified size from accessing the filtration system. Nanoparticles, iron particles, various inorganic compounds, and some larger particles would all sink to the bottom of the conical-bottomed tank once the water is aerated, and the sludge would be pumped out. A conical settling tank with alum added would collect the undissolved ions, minerals, and organic particles. Two tanks are utilized in the activated sludge technique of secondary treatment. One is a clarifier, where heavy particles and other impurities settle out, and the other is a proton exchange, where beneficial bacteria are grown. The goal of the recycling stream known as recycle sludges (RAS) is to maintain an acceptable microbial load. Particle settling is enhanced when an air compressor is used in a clarifier.

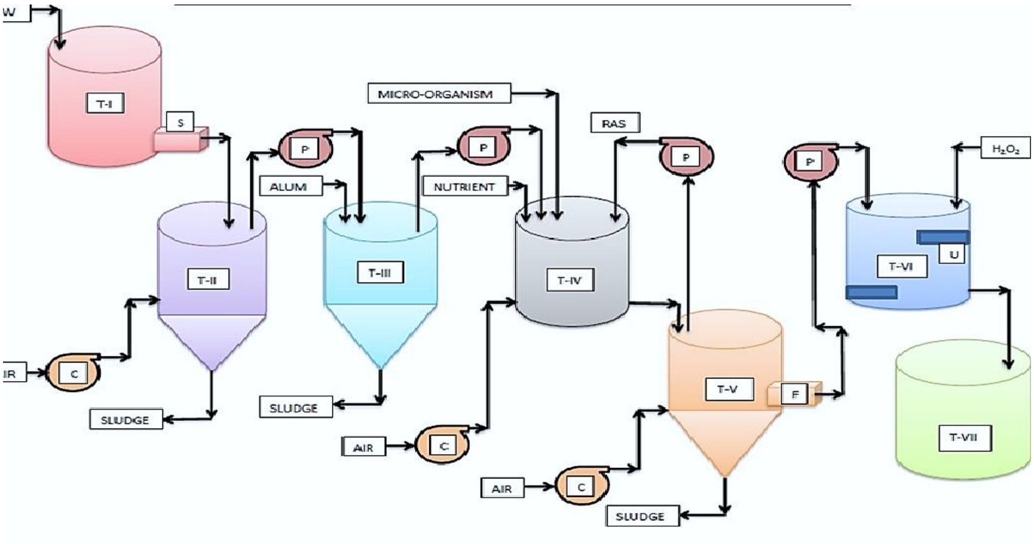

Figure.4 Water Treatment Plant

Process Description

A cylindrical storage tank is used to hold raw water and allow heavier particles like sand and clay to settle out. A filtering screen has been installed at the tank's discharge point to filter out any oversized debris.

Following the pre-treatment phase, the water undergoes primary treatment, during which it is first aerated, causing heavier particles such as metals, inorganic compounds, and iron to settle to the bottom of the tank. Subsequently, the water undergoes a sedimentation process in an alum-treated sedimentation tank, where the remaining organic and inorganic particles and ions are removed. The first stage of water purification is now complete.

Secondary treatment, often known as the activated sludge process, is next applied to the water. Microorganisms are grown in a lab and given the nutrients they need to thrive. Microbes in carbon dioxide essentially decompose organic molecules. They also cut down on the fertilizer nutrients of nitrates and phosphates. Trace elements such as potassium, magnesium, and iron are used alongside these substances, while calcium, salt, and silica may be essential for microbial development. Moreover, they may need microquantities of zinc, copper, cobalt, manganese, and molybdenum to flourish.

In the clarifier tank, activated sludge is used to get rid of the settled contaminants. Several contaminants are removed from the water during the secondary treatment procedure. A ultra-filter is installed at the clarifier's outlet to trap any stray cultivated microorganisms before they may escape. To provide the most efficient removal of unwanted substances, a recycling stream connects the clarifier to the aeration tank. The secondary procedure is now finished.

The advanced oxidation tank is where the water advances to the tertiary treatment phase. Here, hydroxyl radicals are produced by exposing the water to ultraviolet light and to H2O2. In this process, any inorganic chemicals present will decrease and settle out along with any organic compounds that may have been present beforehand. UV light is responsible for the

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microorganism's nucleic acid, killing 99.9 percent of the microbes. This AOP is useful for removing color and odor as well as lowering COD levels. This concludes the last stage of purification. After the water has been purified, it may be used for a variety of purposes, including but not limited to: irrigation, industrial processing, household cleaning, and drinking as shown in Table 1 and Table 2

Figure.5 The complete plant lay-out

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Table –1: % Reduction in COD and BOD of Chlorella Scenedesmus with other pecies of Algae

S.No.	Name of the Algae species	% Reduction of BOD	% Reduction of COD
1	Nostoc Muscorum	---	20–57.1
2	Chlorella. Pyrenoidosa	92	86
3	Euglena	96	80
4	Chlorella sp	------	50.8
5	Chlorella Scenedesmus	68.75	70

Sl. No.	Tank	Time
1	Raw Water Cum Screening Tank	15 min.
2	Primary Aeration Tank	30 min.
3	Primary Aeration Tank	45 min.
4	Microbial Culture Tank	4.5 hours
5	ASP Settling Tank	1.5 hours
6	Advanced Oxidation Tank	30 minutes

Table-2: Single run settling/resident time for individual tank based on single run

Conclusion

The research found that the WTP was able to treat water effectively at both high and low pollutant loads, and the resulting water was safe for human consumptionIS:10500-compliant water. The level of turbidity in treated water never exceeds what is considered safe. Because of increased turbidity, coagulant usage increases during the monsoon. During the monsoon, there was a surge in demand for disinfectants because of the increased bacterial load. The water's dissolved oxygen levels rise as it passes through the process's several stages. The water's TDS and total hardness somewhat rise due to the addition of chemicals. The amount of water lost during treatment is significantly below the CPHEEO-mandated maximum. Keeping the chlorine concentration in the treated water at 1.5 parts per million ensures that any remaining bacterial contaminants are eliminated.

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