WASTE WATER TREATMENT UTILIZING INORGANIC NANOPARTICLE SUSPENSION IN THE PRESENCE OF SOLAR RADIATION

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Abstract

The generation of harmful trade wastes is a thoughtful delinquent knowledgeable by countries. A few strategies are recognized to decontaminated the squander effluents having distinctive concentrations of the hurtful items. But now-a-days, the foremost of the investigate is going on the photocatalyst handle utilizing catalyst as TiO2 and ultra-violet radiation of sun-based range to detoxify the squander water of industry. Within the show work, squander water which contains the drain contaminants detoxify by utilizing the compound illustrative collector of concentration proportion of 1.15 with TiO2. Within the conclusion of the report, comes about are appeared of the explore. Comes about are included the impact of sun-based radiation and neighborhood time on the broken-up oxygen and framework effectiveness.

Keywords: *Solar Radiation, TiO_2 Nanoparticles, Dissolved Oxygen, Waste Water, Thermal Efficiency.*

INTRODUCTION

Characteristic daylight, fundamentally the UV radiation, can be utilized to anticipate the development or to kill the microorganisms accessible within the waste water from the different industries, such as paper and mash industry, drain dairies, materials, etc., due to this, the modern investigate pointed at the decontamination of harmful water to supply microbe-free drinking or recyclable water on the least taken a toll [1-3]. The analysts have centered on the explanation of common sun powered radiation to treat the waste water, primarily for the little volumes in sun powered collectors lighted for periods of up to 8 hours, known as Sun powered Water Cleansing (SODIS). This approach is utilized broadly and demonstrated useful for a broad differing quality of harmful toxins [4-6].

Afsharina et al. [7] combined the effect of solar radiation with the suspension of inorganic nanoparticles to disinfect the waste water from the dairy industries. They also compared the photolysis process and photocatalysis process and found the disinfection was faster in the later as compared to the photolysis process. To further intensified the photocatalysis process for the treatment of waste water, the use of TiO_2 nanoparticles is covered as a massive research field. This kind of research is carried out over the past decade. The literature motivated the authors to enhanced the understanding of photoreactor behavior for different parameters, such as chemical kinetics, mass flow rate, area covered, and variations in UV insolation [5]. But still, the effective mechanism of the TiO_2 biocidal action is unclear in the literature. The position of reactive oxygen species is not clear, which is directly involved in the photo-killing process, in particular the identities of the main reactive oxygen species (ROS), which not only include the OH radical, however additionally O_2^-, and H_2O_2. A current contribution by using Blanco et al. [9] demonstrates the critical function of the -OH- acting both independently or in collaboration with other ROS- inside the inactivation of E. Coli in presence of UV-illuminated TiO_2 particles with splendid linear correlation between steady-state concentrations of -OH and the fees of E. Coli inactivation [8].

In the present study, the suspension of inorganic nanoparticles is used in the presence of the solar radiation in a compound parabolic collector to treat the waste water from the dairy industries. The effect of solar radiation throughout the day on the dissolved oxygen is also investigated.

EXPERIMENTATION

On the premise of literature audit, it was concluded that the concentrating sun-oriented collectors are not so valuable for the photocatalysis prepare since in this explore warming of the waste water isn't a purpose, but to

gather all the sun powered radiation included coordinate and diffuse radiation on the photoreactor [9-11]. The concentrating sun-oriented collectors are utilized as it were for the increment the temperature of working liquid; subsequently, the non-concentrating sun powered collectors can be utilized. The level plate collector isn't competent to assimilate both, coordinate and diffuse radiation. But the concentrating sun-oriented collectors enter more radiation over the safeguard tube. Hence, for the show work of photocatalysis prepare, the compound illustrative collectors having moo concentration proportion of the arrange ~ 1-2, is utilized for the detoxification to supply more sum of bright radiation.

TiO2 is the leading choice as a catalyst for the debasement of the bacteria within the waste industrial water. Usually non-toxic, cheap and effortlessly accessible and we will effortlessly extricate the TiO2 from the treated water. For TiO2, vitality required for the moving of electron from valance bond to conduction bond is effectively picked up from the UV radiation of sun powered range. On the basis of past tests, the ideal plan thought and accessibility of the fabric, information which is utilized for the planning of different components of the photocatalysis framework is given underneath.

For the experiment purpose,

- Concentration Ratio = 1.15
- Semi-angle of Acceptance = 60°
- Diameter of Photoreactor (D) = 30 mm
- Aperture Length = 105.086 ~ 105 mm
- Depth = 57.53 ~ 58 mm
- Length = 50 cm.
- Material For Collector = Aluminum
- Material for the photoreactor = Normal Glass
- Catalyst = Titanium Dioxide (TiO_2)
- Waste water source = Waste Water sample contain the contaminated of milk and detergent which is used for the washing of vessels used for the collecting and/or storing the milk and/or milk products.

After fabrication the setup, as shown in figure 1, experiments conducted to find the value of dissolve oxygen. The experiment was conducted with the Compound parabolic Collector and Titanium Di-Oxide by using the milk waste water.

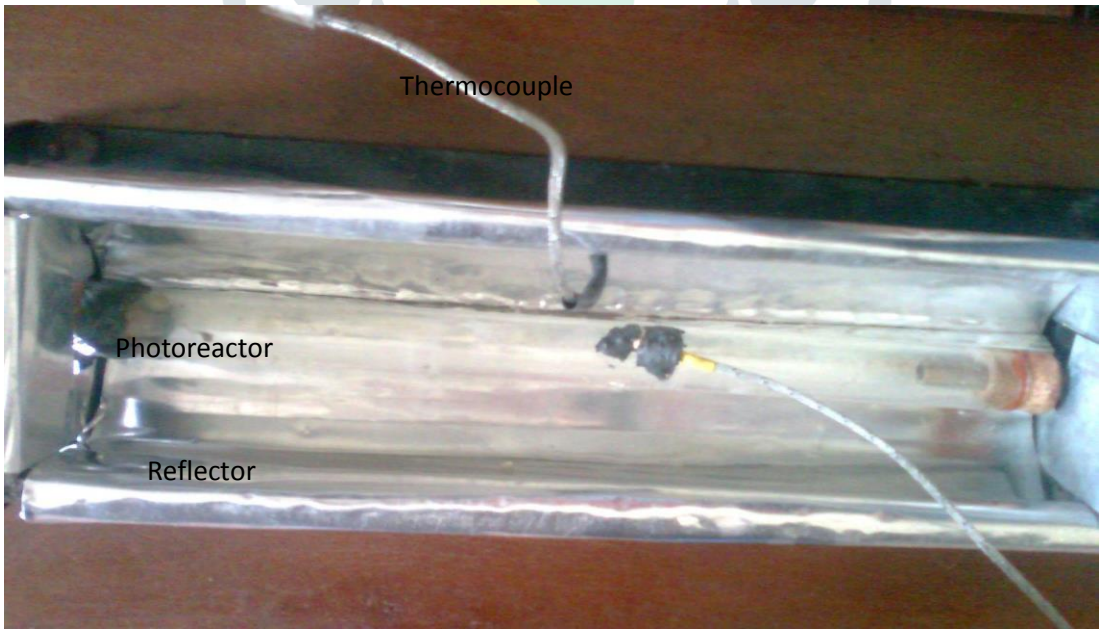

Figure 1: Experimental Setup

DATA REDUCTION

The following mathematical formulas have been used to calculate the various efficiencies and useful energy. The optical efficiency of the collector is a function of the absorptivity, reflectivity and transmissivity, and given by

$$\eta_o = \rho_m^{\bar{n}}.\tau\alpha.\delta$$
$$\delta = \frac{G_b}{G_t} + \frac{1}{CR}.\frac{G_d}{G_t}$$

Here, δ is the declination angle, and CR is the concentration ratio. The useful energy is the energy equal to the total incident solar energy subtracted by the all losses associated with the solar collector, and can be obtained from the following formula

$$q_u = A_c\left[G_t.\tau\alpha - U_L\left(T_p - T_a\right)\right] = mC_p[T_o - T_i]$$

The collector efficiency can be obtained by

$$\eta = F_R[\eta_o - U_L(\frac{T_i - T_a}{G_b C})$$

Where heat removal factor is given by

$$F_R = \frac{mC_p}{A_r U_L}(1 - \exp\left[\frac{U_L F' A_r}{mC_p}\right])$$

And the collector efficiency factor is estimated by the following equation

$$F' = \frac{\frac{1}{U_L}}{\frac{1}{U_L} + \frac{D_o}{h_{fi}D_i} + \frac{D_o}{2k} ln\frac{D_o}{D_i}}$$

The amount of dissolved oxygen was tested and calculated by the titration of the treated waste water in the environmental lab at National Institute of Technology, Calicut. The pH value of the sample was also tested at the same place.

RESULTS & DISCUSSION

Based on the formulas mentioned in the previous section, the different efficiencies are calculated along with the dissolved oxygen and pH variation with the solar radiation and local time.

Optical Efficiency

The optical proficiency of the compound illustrative collector is calculated and appeared in table 1. The measured values of diffuse and bar sun-based radiations portrayed that the sum of pillar or coordinate radiation is exceptionally tall as compared to the diffuse radiation, which expanded with the neighborhood time. Whereas the worldwide radiation, which is fundamentally depends on the bar radiation, diminished with the neighborhood time conjointly influences the optical effectiveness of the CPC. The thermodynamic examination of the CPC was too conducted to calculate the valuable vitality of the compound illustrative collector, as appeared in table 2. The mass stream rate and channel temperature of the squander water were kept up at consistent. It was found that the outlet temperature of the squander water was kept expanding with the nearby time, which leads to the increase within the valuable vitality of the compound illustrative collector.

Table 1. Thermal efficiency of the solar collector.

Local Time	G_d (W/m^2)	G_b (W/m^2)	G_t (W/m^2)	δ	η_o
01:00 PM	70.578	810.422	861.4	1.012	49.40%
01:30 PM	107.2	759.8	849.9	1.003	48.37%
02:00 PM	150.6	657.9	794	0.993	47.60%
02:30 PM	208.5	589.6	778.89	0.989	47.19%
03:00 PM	227.3	530.9	742.9	0.980	46.68%

Table 2: The useful energy collected by the photoreactor.

Local Time	m	T_i(°C)	T_o(°C)	Q_u (kJ/kg)
01:00 PM	0.318 kg	31	33	2.659
01:30 PM	0.318 kg	31	35	5.31
02:00 PM	0.318 kg	31	37	7.97
02:30 PM	0.318 kg	31	38	9.30
03:00 PM	0.318 kg	31	38.5	9.96

After calculating the optical efficiency of the system and useful heat gain by the systems, the overall thermal efficiency of the CPC system was calculated and shown in table 3. The amount of the diffuse radiation increased with the local time, leads to reduction in the beam radiation. A decrement in the efficiency was observed due to reduction in the beam radiation with the local time.

Table 3: Thermal efficiency of the system.

Time	G_d (W/m^2)	G_b (W/m^2)	η (%)
01:00 PM	70.578	815.422	32.31%
01:30 PM	197.2	799.8	31.91%
02:00 PM	220.6	740.9	30.67%
02:30 PM	248.5	661.6	30.23%
03:00 PM	262.3	634.9	29.89%

For the settled value of mass flow rate, at the unfaltering state, the test of treated waste water from the CPC framework were collected and utilizing the test, the amount of broken-down oxygen was measured for each test to discover the impact of photocatalysis handle on the detoxification prepare. The variety within the pH esteem with regard to the nearby time is appeared in figure 2. It was clearly found that the pH esteem expanded with

the neighborhood time, when the diffuser radiation portion within the worldwide sun-oriented radiation increments. It was found that with the nearby time, the pH esteem of squander water expanding towards the unbiased state of the water, and the sum of the broken up oxygen also increased with the nearby time, as appeared within the figure 2 and 3. In any case, the sun powered worldwide radiation diminished at the same time. It appears that the sum of worldwide radiation didn't influence the method of detoxification. As the amount of ultraviolet radiation incident over the collector remain same, which boost the process of photocatalysis in the presence of TiO_2 nanoparticles. Therefore, it was found that the amount of dissolved oxygen is a primary function of the diffuse radiation, as shown in the figure 4, which increased with the amount of diffused radiation.

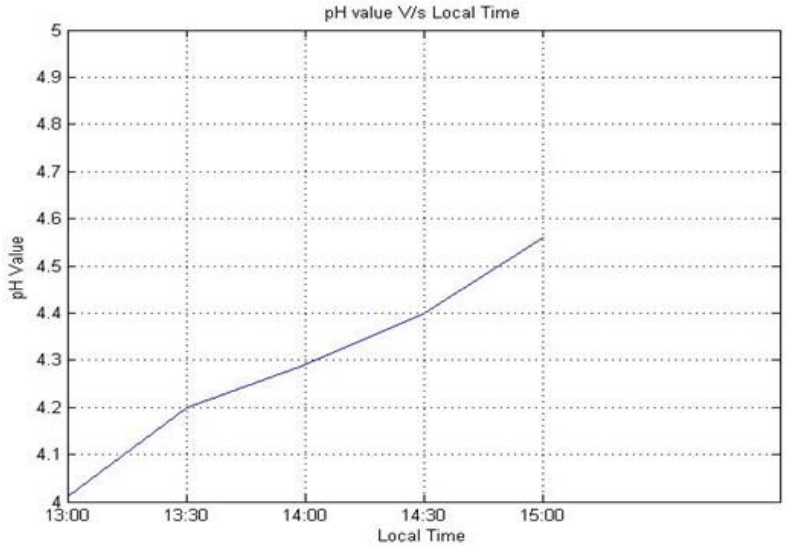

Figure 2: A plot showing the variation in pH value with local time.

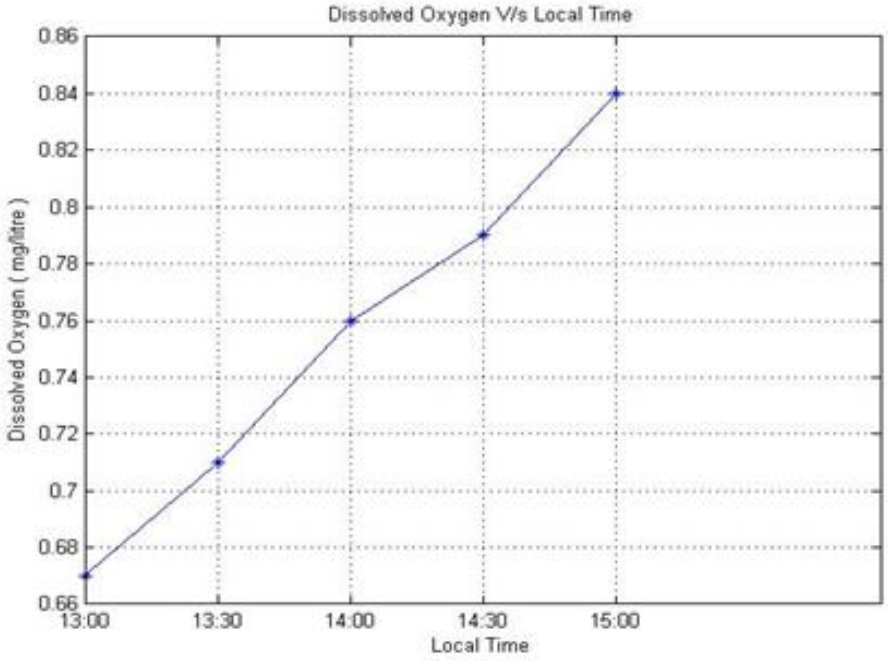

Figure 3: Graph between the dissolved oxygen and local time.

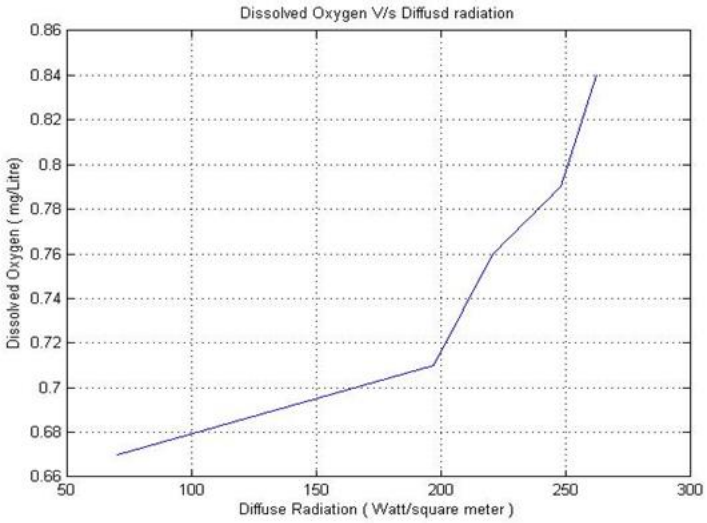

Figure 4: Graph between the dissolved oxygen and diffuse radiation.

CONCLUSION

Within the present work, a compound illustrative collector was plan and created for the detoxification of the dairy profluent. It is clear from the test that the rate of detoxification of squander water is basically depends on the diffuse radiation since diffuse radiation has the most extreme division of ultra-violet radiation, which is basic for the photo-catalysis. From the comes about, the amount of diffuse radiation expanded close the time of nightfall. The sum of titanium di-oxide is additionally playing a crucial part within the handle of photocatalysis since when the sum of TiO2 increments, the transmittance of radiation within the photoreactor diminishes. In this try, the sum of TiO2 was steady as 1 gm/liter. After completing the experiments, it can be easily seen from the results that the amount of dissolved oxygen increased with the time of experiment. At the time of starting the experiment, the amount of D.O. was 0.67mg/liter but after 2 hours, the amount of D.O. was 0.84 mg/liter. The maximum thermal efficiency of the system was found about 32.31%, but when direct radiation started to reduce, efficiency was also decreased up to 29.89%.

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