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PHOTO CATALYTIC DEGRADATION OF PARACETAMOL DRUGS FROM PHARMACEUTICAL WASTE WATER USING SOLAR LIGHT/ZNO

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ABSTRACT:
Pharmaceutical waste is one of the major complex and toxic industrial wastes. The pharmaceutical industry produces a wide variety of products. The pharmaceutical industry uses both inorganic and organic raw materials, the latter being either synthetic or of vegetable and animal origin. Antibiotics and vitamins are produced by fermentation of fairly complex nutrient solutions of organic matter and inorganic salts by fungi or bacteria. The % reduction of paracetamol solution for sample 10 ppm concentration with various contact times 30, 45, 60, 75, 90, and 120 mins. respectively. The maximum dyes reduction at 120 mins. which is 80 % and for 90 mins. is 75 %. So, there is no large difference between these two values so we can consider the optimum time for dye reduction is between 90 mins. to 120 mins. The % reduction of paracetamol for various concentration values 5, 10, 15, 20 and 25 ppm. The maximum dyes reduction at 5 ppm which is 83 % for 90 mins. As the concentration of paracetamol in wastewater increases the rate of reduction decreases. The concentration of paracetamol in wastewater is an important parameter that impacts the rate of reduction of paracetamol from the wastewater. The amount of catalyst (ZnO) used for treatment is fixed which is 0.5-1 gm/l using solar radiation as a light source. The % reduction of Paracetamol for various pHs 2, 4, 6, 8, and 10 for 10 ppm paracetamol solution are 30, 50, 60, 70 and 80%. The maximum paracetamol reduction for 10 ppm which is 80 % for 90 mins at 10 pH. As the pH of paracetamol in wastewater increases the rate of reduction also increases. The pH of paracetamol in wastewater is an important parameter that impacts the rate of reduction of paracetamol from the wastewater. For an alkaline pH solution, the rate of paracetamol reduction using the ZnO/solar process will be maximum.

KEYWORDS: Pharmaceutical waste; ZnO/solar; Inorganic and organic raw; Complex nutrient solutions; Reduction.

INTRODUCTION

Due to rapid growth of population and industrialization, the requirement for water increases but the natural source of water which is useful for domestic and industrial uses is very limited. Large amounts of wastewater come out from the industrial processes and treatment of this waste is necessary to protect the environment and human beings from harmful effects. Use of water sources could result in the search for additional water sources or even in recycling wastewater treatment plant effluents. The goal of biological wastewater treatment is stepwise oxidation of organic pollutants aiming to achieve complete mineralization. Pharmaceutical production increases for population needs. Demand for the pharmaceutical increases due to rapid growth of population. Production of such products requires lots of processed water which is then converted into wastewater. For fulfilment of the water needs of recycling. The natural water sources are limited so recycling of this wastewater is necessary for fulfilment of industry demand. So, treatment of pharmaceutical wastewater is an important aspect for the world. The experimental work carried out on treatment of pharmaceutical wastewater treatment using solar/ZnO processes which is one of the advanced oxidation processes.

Experimental Analysis

Chemicals and Reagents

1. ZnO
3. 0.1 N NaOH or H2SO4
4. Paracetamol
5. Distilled Water

2. Preparation of Synthetic Waste Water

For 5 ppm (5 mg/L) solution add 5 mg paracetamol powder in 1 L of distilled water. Mix it by stirring for 15-20 min.
Similarly, we can make different concentrations of solution 10 ppm.

3. Experimental Process

Experimental Process for various Contact Time

1. Take 0.5 L of 10 ppm pharmaceutical wastewater in a beaker and stir for mixing.
2. Measure the absorbance of known 10 ppm solution or wastewater.
3. Add 1 gm/ L of ZnO catalyst to a beaker.
4. Stir the solution for 10 min.
5. Keep the beakers of various concentrations of solutions in sunlight.
6. For various time intervals 30, 60, 90, 120, and 150-min withdrawal of sample.
7. Check the absorbance unit for each sample of wastewater with the help of a colorimeter.
8. Calculate the % reduction of various samples by comparing the initial and final absorbance units taken using a colorimeter.
11. Follow this procedure for various pH for 10 ppm solution and calculate the % reduction for the paracetamol.

Experimental Process for various Contact Time

1. Take 0.5 L of 5 ppm pharmaceutical wastewater in the reactor and stir for mixing.
2. Measure the absorbance of known 5 ppm solution or wastewater.
3. Add 1 gm/L of ZnO catalyst in a beaker.
4. Stir the solution for 10 min.
5. Follow the same procedure for 10, 15, 20, and 25 ppm synthetic wastewater solution.
6. Measure the absorbance for the above various ppm solutions.
7. Keep the beakers of various concentrations of solutions in sunlight.
8. For contact time of interval 90-min withdrawal of sample.
9. Check the absorbance unit for each sample of wastewater with the help of a colorimeter.
10. Calculate the % reduction of various samples by comparing the initial and final absorbance units taken using a colorimeter.

Experimental Process for various pH

1. Take 0.5 L of 10 ppm pharmaceutical wastewater in a beaker
2. Stirred for mixing.
3. Stir the solution for 10 min.
4. Measure pH for solution.
5. If pH is less than 7, we can increase it by adding 0.1 N NaOH solution and if pH is more than 7, we can reduce it by adding 0.1 N H2SO4 solution.
6. Make the various pH solutions 2, 4, 6, 8 and 10.
7. Add 1 gm/ L of ZnO catalyst to the beaker.
8. Keep the beakers of various concentrations of solutions in sunlight.
9. for 90 min contact time withdrawal of sample.
10. Check the absorbance unit for each sample of wastewater with the help of a colorimeter.
11. Calculate the % reduction for paracetamol.

RESULTS AND DISCUSSIONS

Absorbance for Various Contact Time for 10 ppm

Table Absorbance for Various Contact Time

Sr. No	Contact Time in Min	Absorbance
Initial	0	0.20
01	30	0.12
02	45	0.10
03	60	0.08
04	75	0.07
05	90	0.06
06	120	0.04

The table shows the absorbance measure for sample 10 ppm concentration with various contact times 30, 45, 60, 75, 90, and 120 mins. Respectively. The initial value of absorbance is 0.16 (before treatment). The final and initial value of absorbance can be used to calculate % Reduction of paracetamol solution from synthetic wastewater for various reaction/contact times for a fixed concentration value of 10 ppm.

% Reduction of Paracetamol = [(Final – Initial)/ Final] * 100

For 30 Min, % Reduction of Paracetamol = [(0.2-0.12)/0.20] *100 = 40
For 45 Min, % Reduction of Paracetamol = (0.20-0.10)/0.20] *100= 50
For 60 Min, % Reduction of Paracetamol= (0.20-0.08)/0.20] *100 = 60
For 75 Min, % Reduction of Paracetamol = (0.20-0.07)/0.20] *100 = 65
For 90 Min, % Reduction of Paracetamol = (0.20-0.06)/0.20]100 = 70
For 120 Min, % Reduction of Paracetamol = [(0.2-0.04)/0.20] *100 = 8
% Reduction of Paracetamol for Various Contact Time for 10 ppm

Table % Reduction of Paracetamol for Various Contact Time

Sr. No	Contact Time in Min	% Reduction of Paracetamol
01	30	40
02	45	50
03	60	60
04	75	70
05	90	75
06	120	80

The table shows the % reduction of paracetamol solution for sample 10 ppm concentration with various contact times 30, 45, 60, 75, 90, and 120 mins. Respectively. The maximum dyes reduction at 120 mins. Which is 80 % and for 90 mins. is 75 %. So, there is no large difference between these two values so we can consider the optimum time for dye reduction is between 90 mins. to 120 mins.

Absorbance at Various Concentrations

The table shows the initial and final values (before and after treatment) for absorbance measures for various concentrations of 5, 10, 15, 20, and 25 ppm. The absorbance measure for 90 mins. Reaction/contact time in a maximum reduction for paracetamol using photo catalytic degradation with Zn

Table Absorbance at Various Concentrations

Sr. No	Concentrations in ppm	Initial Absorbance	Final Absorbance
01	05	0.18	0.03
02	10	0.20	0.04
03	15	0.24	0.08
04	20	0.26	0.10
05	25	0.30	0.15

% Reduction of Paracetamol = [(Final – Initial)/ Final] * 100
1. for 5 ppm, % Reduction of Paracetamol = [(0.18-0.03)/0.18] = 83.3
2. for 10 ppm, % Reduction of Paracetamol = [(0.20-0.04)/0.20] = 80
3. for 15 ppm, % Reduction of Paracetamol = [(0.24-0.08)/0.24] = 66.6
4. for 20 ppm, % Reduction of Paracetamol = [(0.26-0.1)/0.26] = 61
5. for 25 ppm, % Reduction of Paracetamol = [(0.30-0.15)/0.30] = 50
% Reduction of Dyes for Various Concentrations Solution

Table % Reduction Paracetamol for Various Concentrations

Sr. No	Concentrations in ppm	% Reduction of Paracetamol
01	05	83
02	10	80
03	15	66
04	20	64
05	25	50

The table shows the % reduction of paracetamol for various concentration values 5, 10, 15, 20, and 25 ppm. The maximum dyes reduction at 5 ppm which is 83 % for 90 mins. As the concentration of paracetamol in wastewater increases the rate of reduction decreases. The concentration of paracetamol in wastewater is an important parameter that impacts the rate of reduction of paracetamol from the wastewater. The amount of catalyst (ZnO) used for treatment is fixed which is 0.5-1 gm/l using solar radiation as a light source.
Observations for Various pH (10 ppm solution)

Table Absorbance at Various pH

Sr. No	pH	Final Absorbance
	Initial	0.20
01	02	0.14
02	04	0.15
03	06	0.09
04	08	0.07
05	10	0.06

The table shows the absorbance measure for various pH 2, 4, 6, 8, and 10 for 10 ppm paracetamol solution. The absorbance measure for 90 mins. Reaction/contact time in a maximum reduction for paracetamol using photo catalytic degradation with ZnO.
% Reduction of Paracetamol = [(Final – Initial)/ Final] * 100
1. For 2 pH, % Reduction of Paracetamol = [(0.20-0.14)/0.20] = 30
2. For 4 pH, % Reduction of Paracetamol = [(0.20-0.10)/0.20] = 50
3. For 6 pH, % Reduction of Paracetamol = [(0.20-0.08)/0.20] = 60
4. For 8 pH, % Reduction of Paracetamol = [(0.20-0.06)/0.20] = 70
5. For 10 pH, % Reduction of Paracetamol = [(0.20-0.06)/0.20] = 80
% Reduction of Dyes for Various Concentrations Solution.

Table % Reduction Paracetamol for Various pH

Sr. No	Concentrations in ppm	% Reduction Of Paracetamol
01	02	30
02	04	50
03	06	60
04	08	70
05	10	80

The table shows the % reduction of paracetamol for various pH 2, 4, 6, 8, and 10 for 10 ppm paracetamol solutions are 30, 50, 60, 70, and 80%. The maximum dyes reduction for 10 ppm which is 80 % for 90 mins at 10 pH. As the pH of paracetamol in wastewater increases the rate of reduction also increases. The pH of paracetamol in wastewater is an important parameter that impacts the rate of reduction of paracetamol from the wastewater. For an alkaline pH solution, the rate of paracetamol reduction using the ZnO/solar process will be maximum.

Effect of Various Parameters on ZnO/Solar Radiation Process

1. Effect of pH value

Reaction to be conducted under the conditions of reaction time 90 minutes, catalyst loading 1 gm/l, and different pH values results found that low pH is effective for ZnO/Solar Radiation process and the best removal efficiency is obtained at a pH =8 or more. At the higher value of pH it is better to remove inorganic carbons from waste water as they can scavenge hydroxyl radicals.

2. Effect of Reaction Time

Reaction time is an important factor for the treatment of dye wastewater by the ZnO/Solar Radiation process. As per experimental studies, the optimum reaction time is 90-120 minutes with more than 80 % of dye reduction from the wastewater.

3. Effect of Catalyst ZnO Loading

For this ZnO/Solar Radiation process, ZnO major chemicals determine operation costs as well as efficiency. As per the experimental study, the optimum amount of catalyst obtained is 0.5-1 gm/l of wastewater treated.

4. Effect of Wavelength of Solar Light

As the intensity of solar radiation/light increases the rate of photolysis of ZnO increases. The optimum value of 350-450 nm after that rate of degradation reduced. The value of solar intensity should be $\lambda < 450$ nm. The value of solar radiation is between 100-400 nm. So, it can be applied for degradation with ZnO and gives the best result for the removal of dyes.

5. Effect of Paracetamol Concentration

As the concentration of paracetamol increases, the rate of reduction decreases. We experimented with % reduction of paracetamol for various concentration values 5, 10, 15, 20, and 25 ppm. The maximum paracetamol reduction at 5 ppm which is 83 % for 90 minutes. As the concentration of paracetamol in wastewater increases the rate of reduction decreases. The concentration of paracetamol in wastewater is an important parameter that impacts the rate of reduction of paracetamol from the wastewater.

4. CONCLUSIONS

Both solar light and catalyst are important factors in paracetamol degradation. The initial concentration increases for both drugs lead to a reduced degradation rate with the foundation of the mentioned weights of ZnO. Parameters that affect the photocatalytic degradation of pharmaceutical wastewater are initial effluent concentration, catalyst dosage, irradiation time, the intensity of light, and the effect of pH. When the amount of Photo catalyst load increased in the wastewater photocatalytic degradation efficiency significantly increased. Photocatalytic degradation might be facilitated by using semiconductor ZnO which acts to increase the surface area of paracetamol solution to exposed solar light which results in increased photo catalytic degradation efficiency. As the concentration of paracetamol in wastewater increases the rate of reduction decreases. The concentration of paracetamol in wastewater is an important parameter that impacts the rate of reduction of paracetamol from the wastewater. As the pH of paracetamol in wastewater increases the rate of reduction also increases. The pH of paracetamol in wastewater is the important parameter that impacts the rate of reduction of paracetamol from the wastewater. For an alkaline pH solution, the rate of paracetamol reduction using the ZnO/solar process will be maximum.

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