Removal of Paracetamol Drugs from Pharmaceutical Wastewater Using TiO_2/Solar and ZnO/Solar

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ABSTRACT

The effect of concentration on % reduction of paracetamol using ZnO/Solar and TiO_2/Solar process. For concentrations 5, 10, 15, 20, 25 and 30 ppm solutions % reduction of paracetamol using ZnO/Solar process are 78, 70, 65, 61, 54, 51 and using TiO_2/solar process are 80, 73, 68, 64, 57, 54 resp. for 120-150 contact time. As per observation as the concentration of paracetamol increase, rate of reduction decrease. As per observations both the processes are economical and having same efficiency for paracetamol reduction. For TiO_2/Solar Process gives more reduction of drugs than the ZnO/Solar process. There is little bit difference in reduction of paracetamol between two processes. Both the processes are effective for paracetamol reduction. As the concentration of pollutant increase the rate of reduction decreases. As per observation the maximum reduction for paracetamol drugs from synthetic wastewater is 72.5 and 69.44% at 150 min time with 10 ppm concentration of dugs for TiO_2/Solar and ZnO/Solar process resp.

Keywords –TiO2/Solar Process, ZnO/Solar Process, Reduction of Paracetamol, Concentration, pH, Contact Time.

Introduction

Due to rapid growth of population and industrialization the requirement of water increases but the natural source of water which is useful for the domestic and industrial uses is very limited. From the industrial process the large amount of waste water is coming out treatment of this waste is necessary to protection of environment and human being from harmful effect. Availability of water is becoming an increasing concern in the globalized world, both in developed and in developing countries. A sustainable use of water sources could result in the search of additional water sources or even in recycling wastewater treatment plant effluents. Goal of biological wastewater treatment is stepwise oxidation of organic pollutants.

Materials

1. Hydrogen Peroxide (H_2O_2)
2. Titanium Oxide (TiO_2)
3. Acid or Alkali
4. Solar Light
5. Zinc Oxide (ZnO)

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Chemicals and Reagents

1. ZnO
2. TiO_2
3. 0.1 N NaOH or H_2SO_4
4. Paracetamol
5. Distilled Water

Experimental Process for various Contact Time

1. Take 0.5 L of 10 ppm pharmaceutical wastewater in beaker and stirred for mixing.
2. Measure the absorbance of known 10 ppm solution or wastewater.
3. Add 1 gm/ L of ZnO/TiO_2 catalyst in beaker.
4. Stirred the solution for 10 min.
5. Keep the beakers of various concentrations solutions in sunlight.
6. For various time of interval 30, 60, 90, 120 and 150-min withdrawal of sample.
7. Check absorbance unit for each sample wastewater help of colorimeter.
8. Calculate % reduction of various for paracetamol by comparing initial and final absorbance unit taken using colorimeter.

11. Follow this procedure for various pH for 10 ppm solution and calculate the % reduction for the paracetamol.

Experimental Process for various Concentration

1. Take 0.5 L of 5 ppm pharmaceutical wastewater in reactor and stirred for mixing.
2. Measure the absorbance of known 5 ppm solution or wastewater.
3. Add 1 gm/ L of ZnO/TiO_2 catalyst in beaker.
4. Stirred 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 above various ppm solution.
7. Keep the beakers of various concentrations solutions in sunlight.
8. For contact time of interval 90-min withdrawal of sample.
9. Check absorbance unit for each sample wastewater help of colorimeter.
10. Calculate % reduction of various for paracetamol by comparing initial and final absorbance unit taken using colorimeter.

Experimental Process for various pH

1. Take 0.5 L of 10 ppm pharmaceutical wastewater in beaker
2. Stirred for mixing.
3. Stirred the solution for 10 min.
4. Measure pH for solution.

5. If pH less than 7 we can increase by adding 0.1 N NaOH solution and pH more than 7 we can reduce by adding 0.1 N H_2SO_4 solution.

6. Make the various pH solutions 2, 4, 6, 8 and 10.

7. Add 1 gm/ L of ZnO/TiO_2 catalyst in beaker.

8. Keep the beakers of various concentrations solutions in sunlight.

9. For 90 min contact time withdrawal of sample.

10. Check absorbance unit for each sample wastewater help of colorimeter.

% Reduction of Paracetamol Using TiO_2/Solar

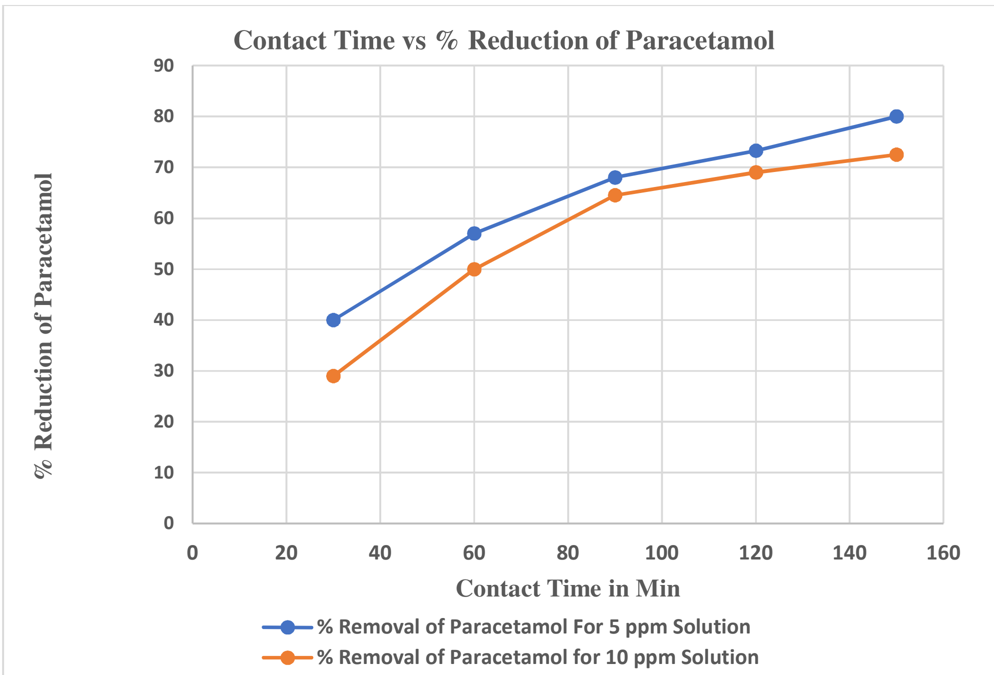

Fig. Graphical Representation % Reduction of Paracetamol for TiO_2/Solar

For 5 ppm solution at contact time 30, 60, 90, 120 and 150 mins % reduction for paracetamol drugs is 40, 57, 68, 73 and 80 resp. using TiO_2/Solar process. For 10 ppm solution at contact time 30, 60, 90, 120 and 150 mins % reduction for paracetamol drugs is 29, 50, 64,69 and 72.5 resp. using TiO_2/Solar process. % Reduction increases with increase in contact time. The max. reduction shown at 120-150 mins.

Graphical Representation of % Paracetamol Reduction

For 5 ppm solution at contact time 30, 60, 90, 120 and 150 mins % reduction for paracetamol drugs is 33.3, 50, 62.5, 71.5 and 77.7 resp. using ZnO/Solar process. For 10 ppm solution at contact time 30, 60, 90, 120 and 150 mins % reduction for paracetamol drugs is 21, 42, 58, 64.5 and 70 resp. using ZnO/Solar process. The % reduction increase with increase in contact time. The max. reduction shown at 120-150 mins. For 5 and 10 ppm max. reduction at 150 mins. can use as optimum time.

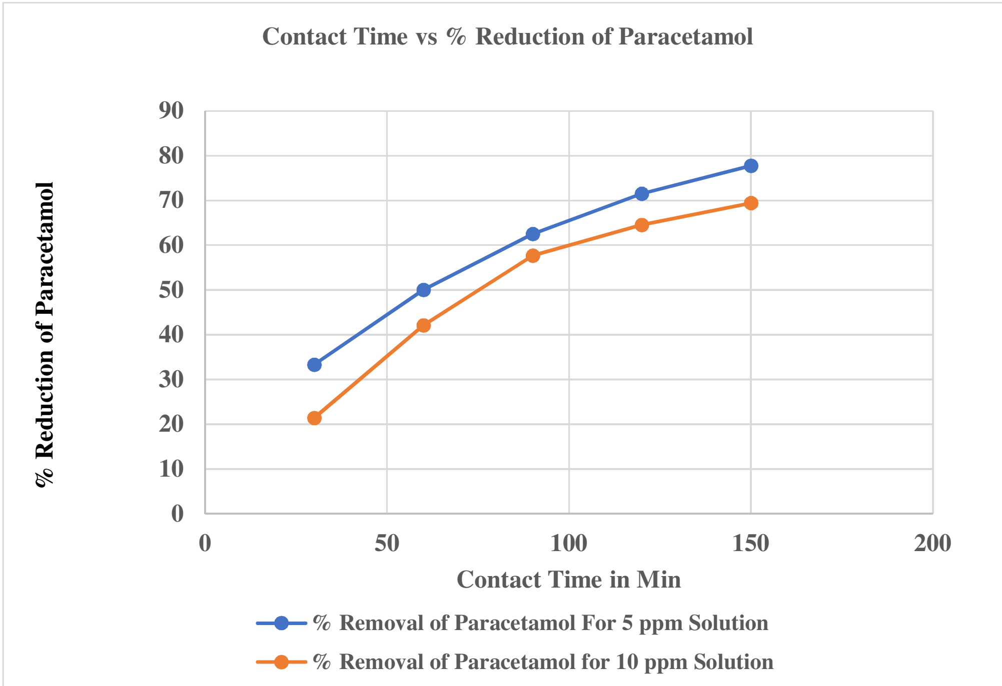

Fig. Graphical Representation of % Paracetamol Reduction for ZnO/Solar

Graphical Representation of % Reduction of Paracetamol 5 ppm

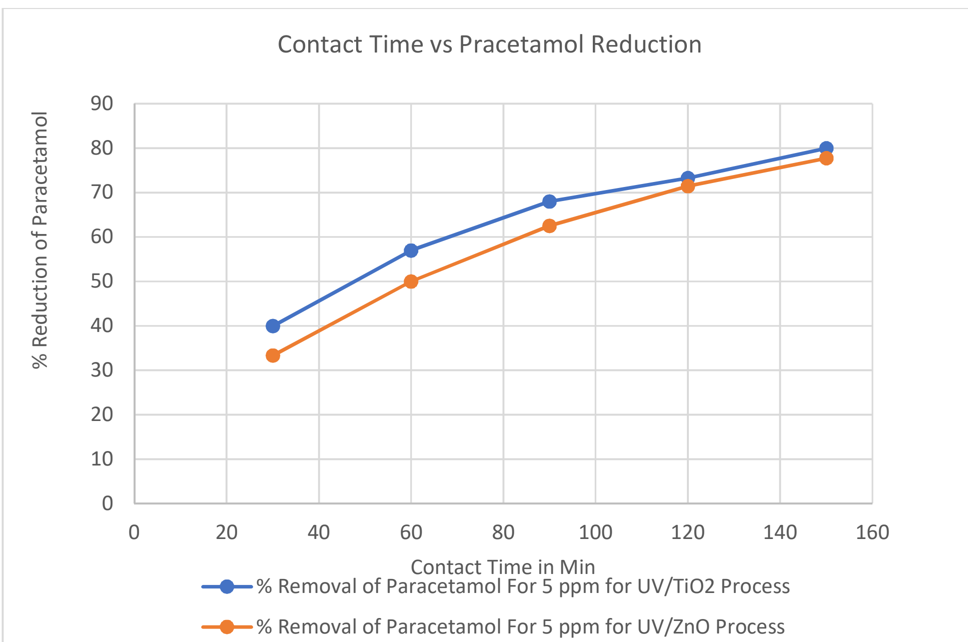

Fig. Graphical Representation of % Reduction of Paracetamol 5 ppm

For TiO_2/Solar $_{\text{Process}}$ gives more reduction of drugs than the ZnO/Solar process. There is little bit difference in reduction of paracetamol between two processes. Both the processes are effective for paracetamol reduction.

% Reduction of Paracetamol 10 ppm

Fig. shows the comparison of two AOP for reduction of paracetamol drugs from synthetic wastewater for 10 ppm at various contact time. For TiO_2/Solar Process gives more reduction of drugs than the ZnO/Solar process. There is little bit difference in reduction of paracetamol between two processes.

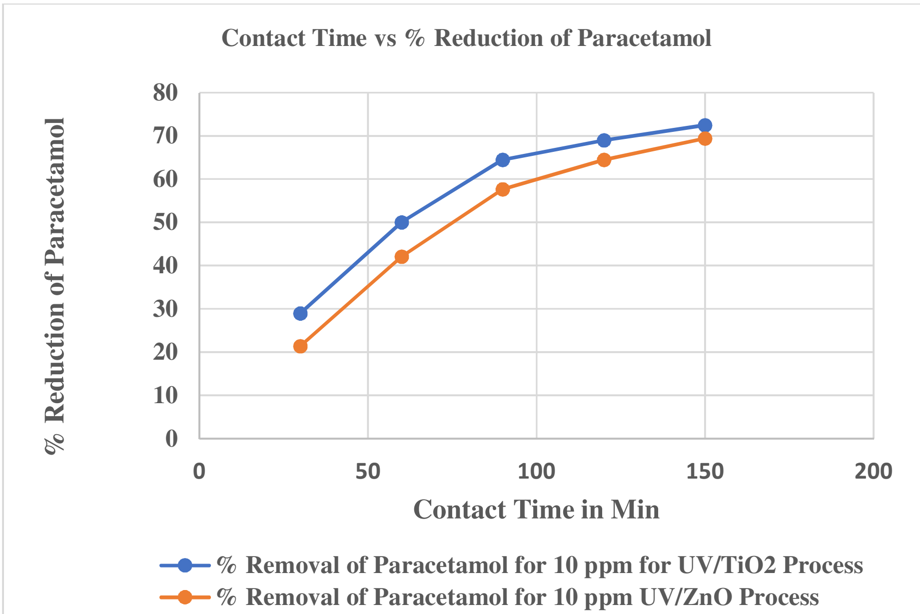

Fig. Graphical Representation of % Reduction of Paracetamol 10 ppm

% Reduction of Paracetamol for ZnO/Solar and TiO_2/Solar at various concentrations

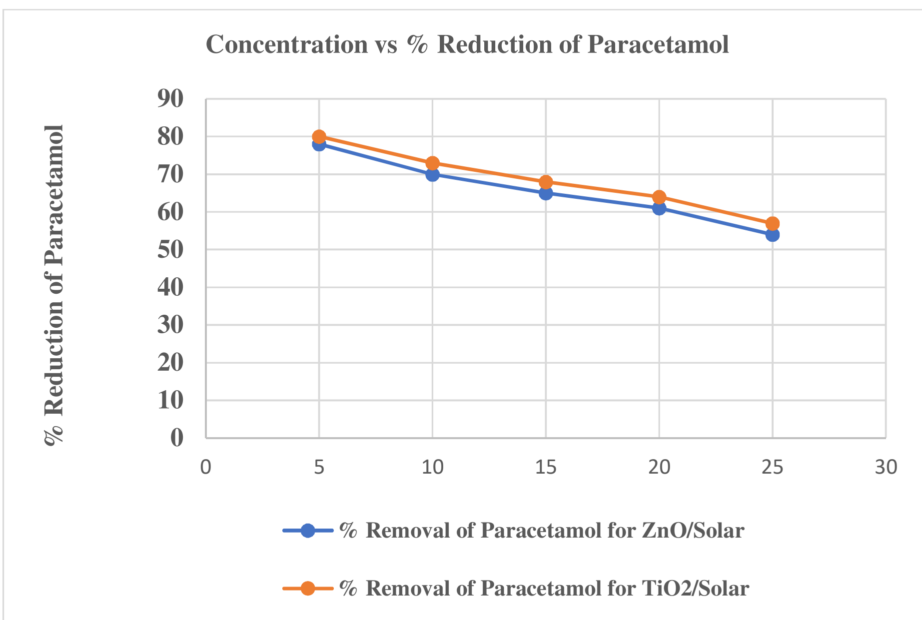

Fig. Graphical Representation % Reduction of Paracetamol for TiO_2/Solar

% reduction of paracetamol using ZnO/Solar and TiO_2/Solar process. As per graphical representation, as the concentration of paracetamol increase, rate of reduction decrease. As per observations both the processes are economical and having same efficiency for paracetamol reduction.

Effect Parameters on Rate of Degradation

1. Effect of Catalyst Weight

The effect of TiO_2 and ZnO catalyst amount on the degradation of paracetamol and procaine solutions at natural ph. Typical weight of TiO_2 and ZnO 1-5 gm/l for 5-50 ppm paracetamol solution. Stability the rate of photocatalytic degradation when amount of catalyst reached to 05 gm/l 25-30 ppm solution.

2. Effect of Initial Concentration Paracetamol Solutions

The effect of initial concentration for paracetamol solutions is important in terms of % reduction. Concentration is studied in the range (5-30 ppm) for both processes TiO_2/solar and ZnO/solar paracetamol solutions.

3. Effect of pH

pH is an important factor in evaluation of photocatalytic degradation rate because the pH change affects the adsorption quantity of organic pollutants. Photocatalytic degradation rate optimal at pH is 8.0 for paracetamol and 4.0 for procaine in presence of certain conditions. pH effect range (4, 6, 8, 10 and 12) for both paracetamols.

4. Effect of Temperature

The study of temperature effect on photocatalytic degradation rate optimal temperature 55-60 ^{O}C for paracetamol with initial concentration 10 mg/l for both processes TiO_2/solar and ZnO/solar & pH solution 6-8 for paracetamol.

4. Effect of Contact Time

As per analysis it’s clear that the % reduction increase with increase in contact time. The max. reduction shown at 120-150 mins. For 5 and 10 ppm max. reduction at 150 mins. can use as optimum time.

CONCLUSIONS

Effect on photocatalytic degradation of pharmaceutical wastewater is initial effluent concentration, catalyst dosage, irradiation time, intensity of solar light and effect of pH. Photocatalyst load increased in the wastewater photocatalytic degradation efficiency significantly increase. Concentration is the important parameter that impact on the rate of reduction of paracetamol from the wastewater. Catalyst (ZnO and TiO_2) use for treatment is fixed which is 1-6 gm/l using solar radiation as light source. As pH of paracetamol in wastewater increase the rate of reduction also increase. pH of paracetamol in wastewater be the important parameter that impact on the rate of reduction of paracetamol from the wastewater. For alkaline pH solution the rate of paracetamol reduction using ZnO/solar process will be maximum. Degradation of pharmaceuticals is highly dependent on the operational parameters of the system. Operating parameters such as initial pH, initial concentration of the pollutant, catalyst loading and irradiation time can influence the removal rate of pollutants. Titanium dioxide, zinc oxide are effective catalysts in photocatalytic degradation of real pharmaceutical wastewater.

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