

## Organic Wastes Degradation by U.V. Radiation

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### ABSTRACT

Indian industries use water in a very high quantity as compared to other countries' water usage. Inefficient water use by industries in India creates a lot of problems. This quantity could be reduced to a minimal by recycling the water after sufficient treatment. This work aims at sufficient in-situ treatment of wastewater and recycling of water for low-grade applications in the industry. Complete destruction of the contaminant is possible using inexhaustible, free source of energy from sunlight thus consuming very less primary energy for its operation. Photocatalytic experiments were carried out using laboratory photo reactor for degradation of phenol wastewater. The experiments were carried out with 0.2 g/l of TiO<sub>2</sub> catalyst for different concentration of phenol wastewater ranging from 100, 300 and 500 ppm. It is found that complete degradation of phenol is possible in a reasonable time (i.e. less than 5 hrs) when concentration of phenol is  $\leq 100$  ppm.

**Keywords:** wastewater, phenol, solar, photocatalytic treatment, potential

### I. INTRODUCTION

Every community produces both liquid and solid wastes. The wastewater is essentially the water supply of the community after it has been fouled by a variety of uses. From the stand point of sources of generation, wastewater may be defined as a combination of the liquid or water carried wastes removed from residences, institutions, commercial and industrial establishments, together with such ground water, surface water & storm water as may be present. Industrial wastes containing dissolved organic compounds have posed and continue to pose serious pollution problems. Although most of the organic compounds found in wastewater can be treated readily, the number of such compounds that are not amenable to treatment or that are only slightly amenable to treatment with the conventional processes presently used is increasing. Moreover, in many cases, little or no information is available on the long term environmental effects caused by the presence of these compounds. To understand the effect more clearly, it is anticipated that more emphasis shall be placed on advanced treatment for the removal of specific contamination.

Since the need for producing "organic free" water has become extremely important, especially in the industrialized nations, continuous efforts are being made to develop methods for purifying water either by removing these impurities or by converting them into harmless products.

A number of methods are currently available to destroy such compounds. In which, the photo catalysis is an emerging water treatment technology that destroys organic contaminates under ambient pressure and at a non-elevated temperature. It is a process in which the illumination of an oxide

semiconductor produces photoexcited electrons and holes. These can migrate to the oxide surface and participate in half-cell reactions that are part of a closed, catalytic cycle. In the aqueous phase, the illuminated surface is widely regarded as a producer of hydroxyl radicals (e.g.  $H^+ + OH^* \rightarrow OH$ ), & these other highly oxidizing initial products of & indirect photochemistry go on to attack oxidizable contaminants i.e. the photocatalysis can mineralize the organic contaminants into simple mineral acid, carbon dioxide & water.

Hence the details of study of effect of various oxidizing agents such as TiO<sub>2</sub>, H<sub>2</sub>O<sub>2</sub>, O<sub>3</sub> etc. during the process of photocatalytic degradation to complete removal of organic waste to batch process as well as continuous process has been undertaken in this study. The use of **photocatalytic oxidation** is the process of absorption of photons acting as a catalyst in producing reactive radicals. This can oxidize organic compounds. Organic compounds are decomposed to form carbon dioxide, water and mineral acids, as final product effect of temperature on this process is very small; therefore this process is referred as a cold process.

### II. MATERIALS AND METHODS

Phenol solution obtained from Merck Chemical Co., was prepared in 100 mg L<sup>-1</sup> concentrations. The concentration of phenol was measured at 500 nm by a Shimadzu spectrophotometer. TiO<sub>2</sub> was used mostly anatase and had a BET surface area of 50 m<sup>2</sup> g<sup>-1</sup> and an average particle diameter of 30 nm. Adjustment in samples was done by using 0.1 N HCl acids (Merck, 37%) and 0.1N NH<sub>4</sub>OH (Merck 25%). A low pressure UV lamp, 0.8 m in length was installed 10 cm above the samples surface and the light intensity was 0.9 J s<sup>-1</sup>m<sup>-2</sup> measured by a Radiometer

at 300 to 400 nm (Hagner EC1-UVA). All analysis were done according to the standard methods (14).

In this research, the photochemical cell consisted of five 250 ml beaker and 5 magnetic stirrers that used for stirring the samples. The temperature of reactors was controlled at 20°C. In the first phase, the beakers were filled with 200 ml of phenol solution (100 mg L<sup>-1</sup>) and in separate stages were contacted with UV TiO<sub>2</sub> and combination of UV/TiO<sub>2</sub>. Also the effects of various parameters include contact time (1, 3, 5, and 9 h), pH (3, 7 and 11) and amount of TiO<sub>2</sub> (0.5 and 1.0 gr L<sup>-1</sup>) in the removal efficiency of phenol were investigated. The polished aluminium was used a reflective material to protect the samples in the absence of radiation. The samples were withdrawn from the beakers with the syringe (10 ml) before and after the photochemical reaction and the residual phenol was measured. Before phenol measurement, the samples containing TiO<sub>2</sub> were centrifuged at 5000 rpm for 10 min, and then the upper liquid layer were sucked with a glass syringe and filtered. Then concentration of phenol in the prepared samples was measured. All experiments were conducted at lab temperature (nominally 20° C).

### III. RESULTS

The results from examinations in pH= 3, 7 and 11 as the function of exposed time in the studied .It is found that phenol degradation efficiency is affected by TiO<sub>2</sub> concentration, UV irradiation and pH of the

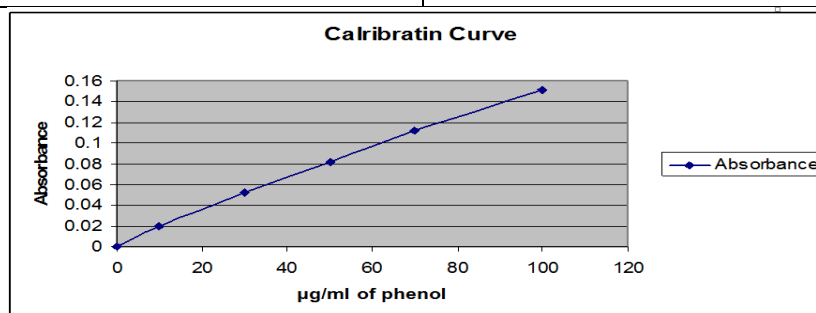
solution. Also the effect of time variation on removal phenol at different pH values is shown in The results show that degradation yield in a 9 h period with pH= 3, 7 and 11 has been 59%, 52% and 83 %, respectively.

### IV. DISCUSSION

The photocatalytic degradation of various toxic organic compounds has been proposed as a viable process to detoxify aquatic solutions. Irradiating pulverulent semi-conductors like TiO<sub>2</sub> in suspension or fixed to various supports in aqueous solutions containing organic pollutants, creates a redox environment able to destroy these pollutants. Solar photocatalytic mineralization of organic water pollutants has a strong potential in the industrial destruction of toxic organics in water as this has been widely demonstrated in recent years, and the applications and target compounds are numerous. Process for phenol degradation is compatible with the environmental. In conclusion, the reaction rates of photocatalytic degradation of phenol were influenced by pH value. Photodegradation can be an alternative treatment method for those contaminants resistant to conventional methods. Photodegradation can be used for complete mineralization of phenol. Since TiO<sub>2</sub> that was used in this study, is a recoverable photocatalyst, UV/TiO<sub>2</sub> process for phenol degradation is compatible with the environmental.

**Table: 4.2.1. Calibration Curve data**

µg/ml of phenol	Absorbance
0	0
10	0.020
30	0.052
50	0.082
70	0.112
100	0.151



**Table: 4.2.2 Percentage degradation of phenol with time (100 ppm of phenol is solution)**

S.No.	Time (Hours)	Percentage degradation
1	0.0	0
2	0.5	6.20
3	1.0	8.00
4	1.5	12.00
5	2	12.8

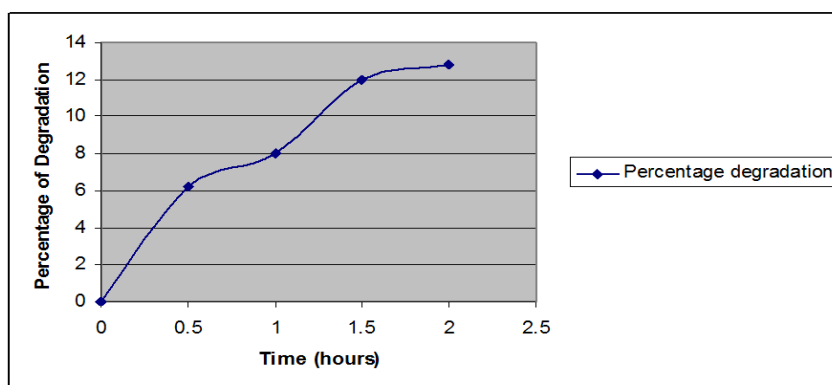


Fig. 4.2.2: Percentage degradation of phenol (100 ppm) Vs time (hours)

Table: 4.2.3 Percentage degradation of phenol with time (300 ppm of phenol is solution)

S.No.	Time (Hours)	Percentage degradation
1	0.0	0
2	0.5	2.9
3	1.0	4
4	1.5	4.2
5	2	4.3

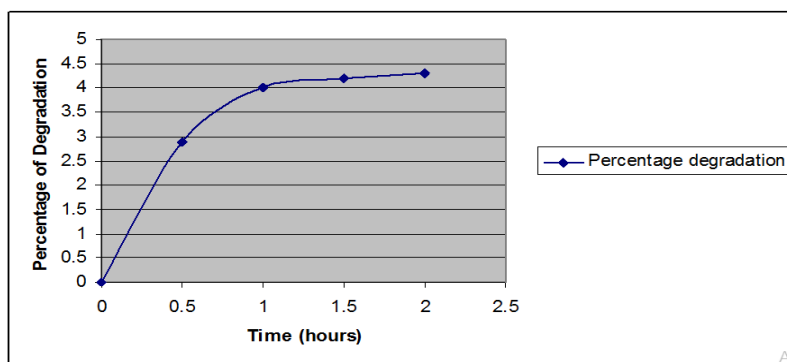
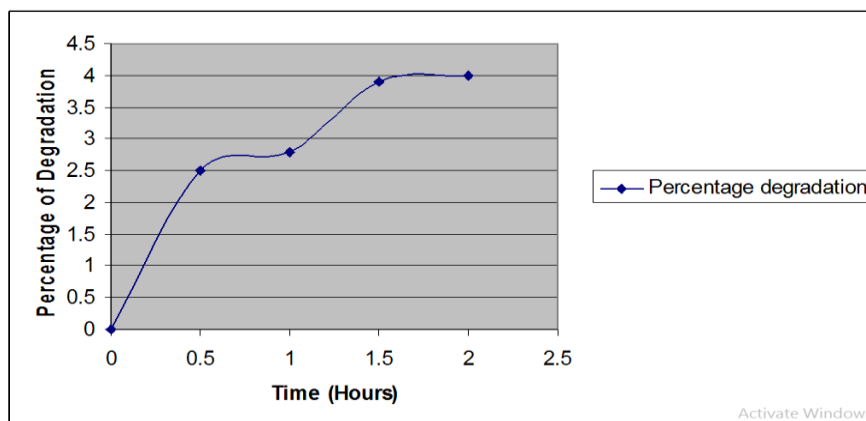


Table: 4.2.4 Percentage degradation of phenol with time (500 ppm of phenol is solution)

S.No.	Time (Hours)	Percentage degradation
1	0.0	0
2	0.5	2.5
3	1.0	2.8
4	1.5	3.9
5	2	4.0



## V. CONCLUSION

The extent of degradation increases with time, but rate of degradation is higher in the initial periods and later on there is a decrease in the same. The extent of degradation decreases with increase in the concentration of phenol.

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