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Solar Photo Catalytic Treatment of Wastewater from Oil Industry for Biodegradability Enhancement

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ABSTRACT:
Oil industry wastewater contains high concentration of organic biodegradable compound as well as a great amount of suspended solids. This water is difficult to treat by conventional biological processes and a great flow variation exists. Photocatalytic advanced oxidation is promising technology for water contains high amount of organic matter. In this study we firstly investigated the application of H2O2 as oxidant combined with light natural in order to reduce the organic matter in sample from oil industry effluents. In the present work advanced oxidation process (UV/H2O2/TiO2), system for the treatment of water contaminated with oil was investigation. The reaction influenced by the input concentration of hydrogen peroxide H2O2, the initial amount of pH, temperature and concentration of oil in wastewater.
Keyword: advanced oxidation processes; photocatalysts; oily wastewater.

INTRODUCTION

Modern world is incorporated with industrialization it serves as a mediator for the development as well as for the economic growth. However this industrialization generates a plenty of industrial wastes into the environment [1]. In the edible oil industry, wastewaters mainly come from the degumming, deacidification and deodorization and neutralization processes [2]. Neutralization step gives sodium salts of free fatty acid (soap stocks). By using of H_2SO_4, it spilt into highly acidic and oily waste water [3]. Its characteristics depend on the type of oil prepared and on the process implemented that are high in COD, oil and grease, sulphate and phosphate content. Previously, the vegetable oil industry effluents are discharged directly into soil or groundwater [4]. In recent years an alternative to conventional methods, is "Advanced Oxidation Processes" (AOPs), such as photocatalysis, sonocatalysis, fenton process, photofenton process and their combinations which are primarily based on the generation of very reactive species such as hydroxyl ($OH^{\cdot}$) free radicals, it have been proven effective for the oxidative destruction, that oxidizes a wide range of organic pollutants quickly[5-8]. Photo catalytic oxidation of organic compounds can be an alternative to conventional methods for the removal of organic pollutants from water. Benefit of the photocatalytic process include its mild operating conditions and the fact that it can be activated by solar light, thus reducing importantly the electric power required and therefore the operating costs. Scientists are investigating many semiconductors that can utilize visible light to degrade a high number of recalcitrant materials in aqueous system [9-10].

Although solar energy is a free, renewable and environmentally friendly energy source, it is not widely used in tropical countries like India. In this study an attempt is made to degrade oil industry effluent by using photocatalysts TiO_2 and solar energy.

MATERIAL AND METHODS

2.1: Chemicals

Effluent was collected from the local oil industry and used as it is without any processing. 30% w/v of hydrogen peroxide (Qualigens) was used in the present study as an oxidant. Effluent was stored in amber colored light resistant pyrex glass bottles. Sodium hydroxide (1N) and Sulphuric acid (1N) were used for pH adjustments. All the chemicals used were of the analytical grade.

2.2: Experimental procedure

The kinetic studies carried out under different experimental conditions were Photolysis, Per-oxidation, sunlight + H_2O_2 + effluent (Optimisation of pH), sunlight + H_2O_2 + effluent (optimisation of oxidant H_2O_2), sunlight + H_2O_2 + substrate (optimisation of photo-catalyst doses TiO_2).

The solar photocatalytic degradation study of 100ml effluent was carried out in flat glass vessel provided with an aquarium pump for the continuous agitation of the sample. During the reaction, the solution was stirred by magnetic pellet to ensure its homogeneity. Photocatalytic activity of TiO_2 was evaluated between 10 am to 4 pm during all sunny days by exposing the effluent solution to direct sunlight. The mixture was then exposed to the sunlight by adding the oxidant, H_2O_2.The time at which the vessel was kept in sunlight was

considered time zero or the beginning of the experiment.

2.3: Analysis

The pH of the solution was measured using Elico pH meter LI-120 equipped with a combined calomel-glass electrode. The aliquot was analysed by Chemical Oxygen Demand (COD) determination. COD analysis was done by using Unifos COD digester and analyzer**.** The percentage of demineralization was calculated by

Percentage degradation = $\frac{(COD)o-(COD)}{(COD)o}$ *100

Where,

$(COD)_o$ = the initial chemical oxygen demand

(COD) = final chemical oxygen demand at a given time

RESULT AND DISCUSSION

3. 1: Effect of pH

pH is one of the most important factor for the generation of hydroxyl radicals. An attempt has been made to study the effect of pH on the degradation of textile effluent under sunlight. It has been observed that the rate of degradation increases with an increase in pH showing maximum degradation at pH-9. But further increases in pH decreases the reaction rate as shown in Fig-1.This may be due to the generation of more hydroxyl radicals. These radicals are produced due to reaction between OH^- ions and hole (h+) of the semiconductor.

3. 2. Effect amount Catalyst

Fig. 2 shows the effect of photo catalyst loading on the rate of degradation of dye at an optimized pH=7. The photo degradation was studied by varying catalyst dose from 1 to 7mg/100ml. The percentage degradation of the dye increases with an increase in the dosage of the photo catalyst. However with further increase in photocatalyst doses decreases the percentage degradation of the dye. The maximum degradation efficiency was attained with 3 mg of TiO_2 photo catalyst and thereafter the rate of degradation decreased. This nature may be due to the screening effect i.e., above a certain amount of catalyst loading, the turbidity of the solution increases and ultraviolet rays start getting scattered, hence reducing the optical path [11]. The aggregation of catalyst particles, which reduces the interfacial area between the textile solution and the photo catalyst, may be other reason for the decrease in the degradation [12]. By carrying out a series of experiments with oxidant H_2O_2 namely 0.3, 0.5, 0.7 &0.9 mg); the optimum H_2O_2 dose was found to be 0.7(Fig. 3). Further increase in H_2O_2 concentration lowered the degradation rate. This is because of the excess H_2O_2reacts with the hydroxyl radicals earlier formed and hence acts as an inhibiting agent of degradation by consuming the hydroxyl radicals responsible for degrading the pollutant molecule [13].

CONCLUSION

The photocatalytic oxidation processes shows excellent result for the decolourisation and demineralization of oil industry effluent in the direct sunlight. pH, amount of oxidant and photocatalytic doses are the important parameters for the degradation of effluent. In this study it is concluded that photocatalytic shows consideration decrease in COD of the effluent thus can be successfully used with solar light in the country like India where sunlight is available the year.

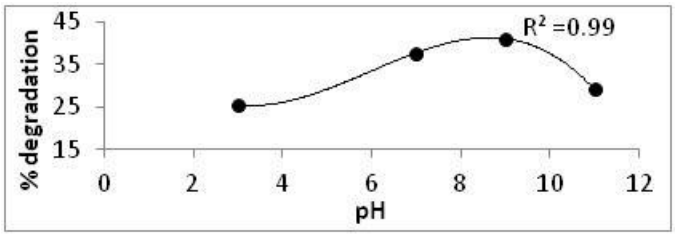

Fig. 1. Effect of pH on the degradation of effluent

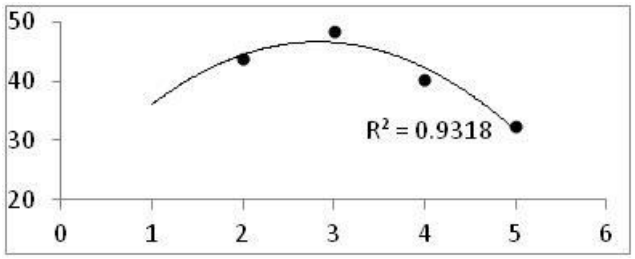

Fig.-2 Effects of TiO_2 doses on the degradation of effluent

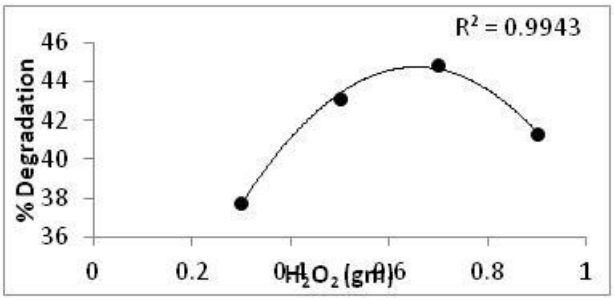

Fig.3. Effect of amount of oxidant on the degradation of effluent

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