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Degradation of the Dye from Wastewater by Hydrodynamic a Cavitation Technique

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Research Article

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ABSTRACT

The experiments were done at a fixed temperature of 30°C with a Trypan blue concentration of 0.1 g/L and a pressure of 5 bar. The degradation of trypan blue dye was high at the optimum conditions of inlet pressure 5 bar and concentration of dye and catalyst in 1:5 ratio about 80%. The addition of TiO2 as nanoparticles catalyst under obtained value at the preliminary experiments was shown that the degradation yield were higher at 5 bar inlet pressure.

INTRODUCTION

Natural water environment today is threatened by a variety of hazardous chemical substances derived from man-made products. The deleterious effects of chemicals on the earth's ecosystems are a cause for serious concerns. The release of toxic wastewater into the natural environment is not only hazardous but also leads to significant environmental problems. The biological processes are unable degrade these compounds completely.

A new approach is investigated where hydrodynamic cavitation is used as a novel technology with an aim of reducing the overall cost of pollutant degradation. Cavitation is the formation, growth and subsequent collapse of cavitation babbles in the lowering liquid and enhance various chemical and physical effects [1]. The effects of cavitation have become very useful in chemical processes in the environmental protection technologies.

Trypan blue is an azo dye; it is used as a vital stain to selectively colour dead tissues or cells blue. The produce hydrodynamic cavitation should react with radicals for removal of pollutants react with the radicals produced by the hydrodynamic cavitation [2]. An attractive, sludge free Alternative for the treatment of wide range of organic pollutants present in wastewater, including synthetic dyes, are so called Advanced Oxidation Processes (AOPs). The cavitation is varied by pressure varation in a flowing liquid which is determined by orifice and venturi.

Firstly, the liquid accelerates in the converging segment as a result of lowering the pressure and thus creating and increasing bubbles. Due to lower process costs and a less complicated structure of reactors, hydrodynamic cavitation is a prospective form of degradation of organic pollutants contained in wastewater.

MATERIALS AND METHODS

In this process Trypan blue dye is used and for the degradation a catalyst TiO2 is also used this can be done by hydrodynamic cavitation technique.

Trypan blue dye

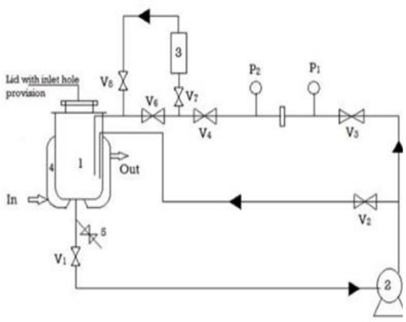
Trypan blue is an azo dye that is used as a dye-stuff. It is a direct dye for cotton textiles. It is having chemical formula C34H24N6Na4O14S4 and molecular mass is 872.88. Appearance is deep blue in aqueous solution. By using tap water as a dissolution medium the solutions were prepared. The experiments were carried out within the range of 30 -35oC.

Wastewater can be treated by using hydrodynamic cavitation technique but high removal of contaminants or impurities from the wastewater usually it combines with advanced oxidation process [3]. Combination of these processes gives higher efficiency in the removal of impurities and degradation of organic compounds compared to individual processes.

Experimental Procedure

For hydrodynamic Cavitation, experiments were performed in reactor (T1) with volume capacity of 1000ml with jacketed system to control the temperature, and the pump(P1) was lifted for the effluent circulated with a maximum electric power of 375 W and a rotation speed range of 1100-3500 rpm for different intervals of time (Figure 1).

Figure 1. Experimental apparatus for hydrodynamic cavitations.



RESULTS AND DISCUSSION

The experimental results obtained by varying the parameters of inlet pressure and concentration of dye for the degradation of trypan blue dye. For this, first absorbance of the dye is analyzed by using the UV spectrometer.

Calibration procedure

To obtain the concentration of unknown sample, the sample and the blank were transferred to the cell and the absorbances were read at 602 nm wavelength. The absorbance was interpreted with calibration curve and the concentration (of unknown sample) was obtained.

Table 1. Calibration for Trypan blue analysis.

Concentration (PPM)	Absorbance
10	0.32
20	0.69
40	1.49
60	2
80	2.53

100	3.2

Effect of pressure

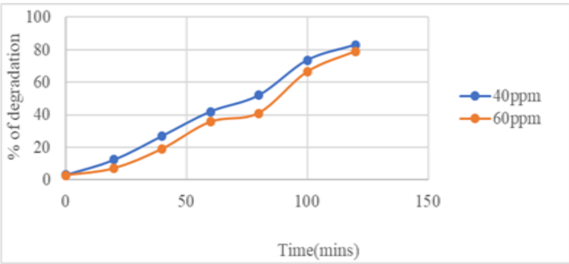
The progressively increase of flow rate has the minimum pressure decreases and there will be a critical flow rate for which the vapor pressure is obtained at the throat [4]. At this operating point, cavitation appears in the section of minimum area. To find the optimum pressure value, each ppm was calculated at each pressure variation then, the dye degradation was analyzed by using UV spectrometer at a time interval of 20 min (Table 1).
The degradation of dye was high at 5 bar after 5 bar pressure the degradation was decreased with increase in the pressure. This is due to the phenomenon known as super cavitation, in which the bubbles produced in the hydrodynamic cavitation reactor do not explode and form a cloud of vapours in the line.

Effect of catalyst

Titanium dioxide is used as a photo catalyst in the process to generate the hydroxyl radicals. The efficiency of catalyst may increase with the rise in the number of active sites for the photo catalytic reaction, which is in parallel with increasing Tio2 dosage, so that it leads to increase in cavitational activity thereby increasing the degradation and decolorization rate [5].

Initially the experiments were conducted by keeping optimum pressure of 5 bars with equal ratio of trypan blue dye and titanium dioxide catalyst and observed that the degradation rate is low. The dye and Catalyst ration were increased as 0.2 g, 0.6 g, 1 g and 1.2 g.

Figure 2. Comparison graph for time vs % degradation of dye at 1 g catalyst.



From the (Figure 2) concluded that even increase in amount of catalyst after 1 g, there is no change in degradation. Because, of the active site's presence in the catalyst. Therefore, the amount of catalyst 1g is the best suitable for the more degradation of trypan blue. The degradation of dye was about 80%.

CONCLUSION

By increasing the catalyst loading the Percentage degradation of triclosan has increased. At optimum conditions the degradation of trypan blue dye was high at the inlet pressure 5 bars and concentration of dye and catalyst in 1:5 ratios about 80%. The addition of TiO2 as a catalyst increases the rate of degradation due to the addition of hydroxyl radicals available for dye oxidation. Degradation of the dye increases with an increase in the concentration of TiO2 to the optimal value and then decreases due to the scavenging of the hydroxyl radicals by TiO2.

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