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RESEARCH ARTICLE

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DYE EFFLUENT TREATMENT OF TEXTILE INDUSTRY USING HYBRID SONOPHOTOCHEMICAL REACTOR

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ABSTRACT

Hybrid Sonophotochemical process as a viable treatment option in the case of textile industry wastewater or dye effluent and different type of reactive azo dyes such as Reactive red120, Reactive orange16 and reactive black5 used in textile industry. The decolorization as well as degradation of dye and dye effluent are examine by photocatalysis, sonocatalysis and hybrid sonophotochemical process. Process were carried out to find the process's standrd optimal operational conditions like pH, H2O2 oxidant concentration, catalyst dosage and initial concentration, to obtain the best results at low cost and their effects have been analyzed for hybrid sonophotochemical treatment. we were examined the comparatively hybrid sonophotochemical degradation and decolorization of different reactive dyes using ultraviolet light as well as sunlight in presence of standard parameters to assure the quick and complete eversion of the toxic organic compounds. The basic mechanism behind the sonophotochemical treatment is formation of a Huge quantity of active free radicals which increase rate of degradation of toxic organic compound. The hybrid Sonophotochemical degradation of textile waste water and different azodyes showed that it could be used large efficient, environment friendly and cost effective technique to complete degradation of different type of dye and recalcitrant organic pollutants.

Keywords— Photocatalysis, Dye Effluent, Sonophotochemical, Sonophotocatalysis, Dye Degradation, Textile

1. INTRODUCTION

The textile industries normally use large number of different type of dyes, active chemicals for the different stages of the production. The textile industries generate a huge amount of effluents, Wastewaters of textile industry is highly colored with large amount of dye and different chemicals. This dye effluent and dye of textile industry causes serious impact on aquatic life and the environment. Biological treatments are not capable to complete degradation of dyes. The establish or conventional wastewater treatment like adsorption, membrane separation, coagulation, flocculation, biological treatment have various type of limitations so they are not capable to complete remove such pollutant from textile wastewater. We have to need new, more efficient, capable, environment friendly and cost effective technique to complete degradation of different type of dye effluent of textile industry. The common characteristics of textile wastewater are high chemical oxygen demand (COD), large quantity of biological oxygen demand (BOD), TSS, high pH, TDS materials, chloride, total nitrogen and the colors The advanced oxidation processes (AOP) are basically based on the rapid generation of large number of highly reactive hydroxyl radicals (HO*) as a primary oxidant can efficiently degrade the recalcitrant compounds and more toxic compound without formation of any secondary pollutants. The advanced oxidation processes are more effective as they are capable for mineralization of a wide range of toxic organic compound material. Different type of methods which involve the rapid generation of free radicals are, (a) photocatalysis (b) sonolysis (c) hybrid sonophotochemical (sonophotocatalysis).

In sonolysis, Ultrasonic waves with frequency more than 22 KHz, which passing through a liquid medium produce its effects via cavitation bubbles. Formation of bubble shows sonochemical effects. The transient cavities of the bubbles produced due to ultrasonic irradiation. That exist briefly expanding to double of initial size before acoustic collapsing into smaller bubbles. The collapse of these bubbles produces local pressures of hundreds of atmospheres and temperatures of thousands of degrees resulting in solute thermolysis and the formation of hydroxyl radical and H_2O_2 by sonolysis of water. The advance photocatalytic process consist of ultraviolet light apply or sunlight apply in presence of semiconductor or photocatalysis that lead the redox reaction on the surface and foray of adsorbed molecule.

Ultrasound and ultraviolet light combination shows that the attractive synergic effect. The main mechanism of behind is that ultrasound degradation of photocatalysis that enhance its surface as well as working performance. That enhance the mass transformation process between the different organic classes and catalyst surface. Which accelerate the rate of degradation of organic compound and pollutant.

In sonophotocatalysis or hybrid sonophotochemical process generation of high pressure and temp due to acoustic cavitation with combination illustration of UV light with active photocatalyst with large surface area are the responsible for formation of large number of hydroxyl radicals and that doing complete degradation of organic pollutant.

2 Objective

Sonophotocatalysis. Combining of two process of irradiations i.e. sonocatalysis and photocatalysis eliminate the drawbacks of individual process and generate more number of active free hydroxyl radicals. The hybrid sonophotochemical treatment does not transfer pollutants from one phase to another and leads to complete mineralization of toxic organic compound and non biodegradable compounds into simpler end products. The main objectives are as follows

- To study dye degradation using photocatalysis and hybrid sonphotochemical process used in textile industry.
- To study the parameter effect on dye degradation and simultaneously find out standard optimized parameters for degradation.
- To study hybrid sonophotochemical effect under both UV and sunlight.

. MATERIALS AND METHODS

3.1 Material

Reactive Red120, Reactive Orange16 And Reactive Black5 are textile dyes are used and textile waste water sample taken from textile industry. Hydrogen peroxide , NaOH, HCl and other reagent obtained from the college laboratory. In this experiment TiO_2 used as a photocatalyst.

3.2 Hybrid Sonophotochemical Reactor

There are three cylinders, having outer ground glass jacket made from borosil glass having cooling jacket has inlet and outlet cooling line provided. 125 watt UV bulb was used. That setup was immersed in sonicator bath 45 kHz thus it is being sonophotocatalytic reactor.

3.3 Method

The experiment were carried out step by step (a) Photocatalysis (b) sonocatalysis (c) hybrid Sonophotocatalysis complete degradation and decolorization of azo dyes. Effect of various experimental parameters such as catalyst addition, sample concentration and addition of H_2O_2 was carried out to arrive at optimized experimental conditions. For that preparation of different concentration of stock solution of different azo dyes

(Reactive Orange 16, Reactive Red120 and Reactive Black5). Initial pH of sample was checked and varied to get the optimized value of the pH. TiO2 Catalyst was fed from 0.1 to 0.5 gm/200ml to optimize the process for maximum pollutant degradation. H_2O_2 was added in the solution. From the range 1 to 7 ml/200 ml to check optimum quantity of oxidant. Solution was treated by sonocatalysis, photocatalysis and hybrid sonophotochemical. The experiments were carried out for the total treatment time of 3 hrs and also compare sonophotocatalytic and photocatalytic experiment carried out for a total treatment time 5 hrs. Samples were withdrawn after 30 min interval and filtered through the 0.45 micron size syringe filter. Results were then optimized regarding catalyst addition, pH and oxidant addition. Experiment done at room temp.

3.3.2 dye effluent of textile industry

Sample collected from textile industry and checked all the characteristics of sample. Process were carried out by sonocatalysis, Photocatalysis and hybrid Sonophotochemical (US + UV/TIO2+ H_2O_2) to identify the most suitable and economical process and find universal standerd optimum parameter for complete degradation and decolorization of dye effluent of textile industry. Results of parameters were optimized regarding catalyst charging, pH and addition of oxidant as above. After the hybrid Sonophotochemical treatment water was filtered and check the characteristics.

4 RESULT

Photocatalytic treatment normally depend upon the some of parameter. These parameter are as follows

4.1.Effect of catalyst charging

experiment were carried out using different concentration of catalyst from 0.1gm per L to 0.5 gm per L for 100 ppm dye solution for determination of optimal amount of catalyst charging. The optimum quantity of TiO_2 catalyst concentration for the degradation of RB5 and other dye is 0.3 gm/ L.

4.2 Effect of solution pH

The experiments were done at different pH that varies from 1 to 8. constant dose of TiO2 (0.3g/l) and H_2O_2 (3ml/200ml). maximum degradation and decolourization achieved at both pH 3 and 4 but pH=4.1 was used as a optimum pH because degradation and decolurization of azo dyes was % more than pH=4.1 i.e. 92% and 98.5%.

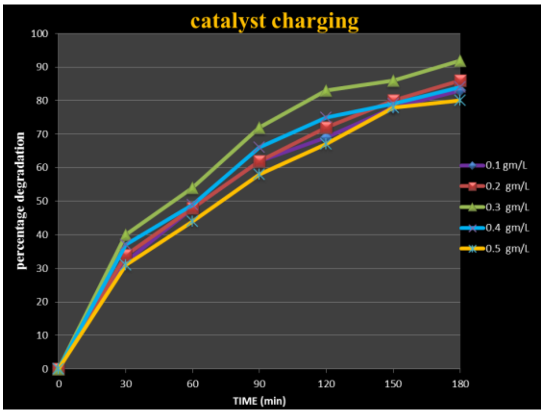

Fig 4.1 effect of TiO_2 catalyst charging on the percentage degradation rate of RB5, RR120, RO16.

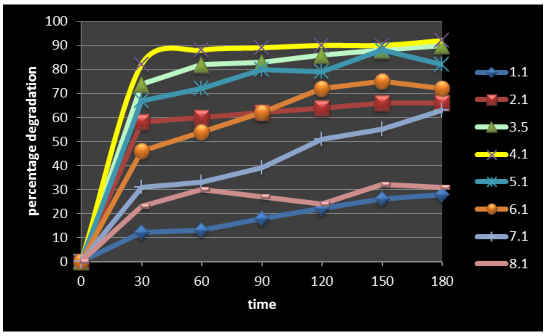

Fig 4.2 percentage of degradation of RB5, RR120 ,RO16 dyes at different PH.

4.3 Effect of initial dye concentration

Increase of dye concentration from 50mg/L to 150mg/L in presence of 0.3g/l TiO_2, 4.1 pH and 3 ml H_2O_2 under UV light. The maximum decolourization and degradation was achieved at dye concentration 100 mg/L. Hence, dye concentration 100 mg/L can be used as an optimum concentration.

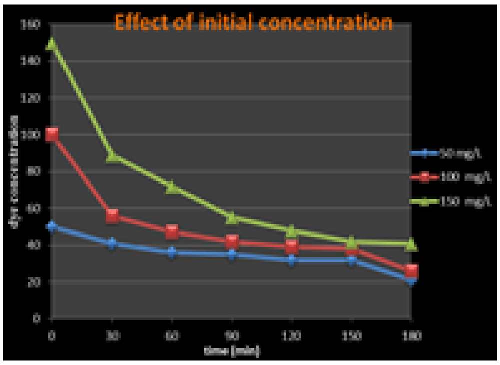

Fig 4.3 Effect of initial dye concentration on rate on degration

4.4 Effect of H_2O_2 oxidant

To optimize the dosage, H_2O_2 varies from 1 to 5 ml/200ml into the dye solution at fixed TiO2 and Ph. Initially dye degradation rate increase by addition of H2O2 concentration. The optimum concentration of H2O2 with initial concentration is 100mg/L at pH 4.1 is 3ml/200ml.

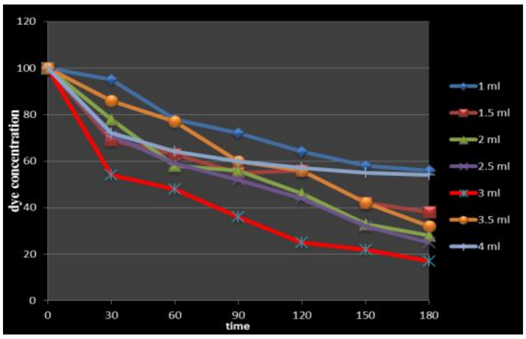

Fig 4.4 Effect of H_2O_2 oxidant on rate on degradation.

4.5 Comparisons of Sonocatalytic, Photo -catalytic and hybrid sonophochemical (Sonophotocatalytic) treatment.

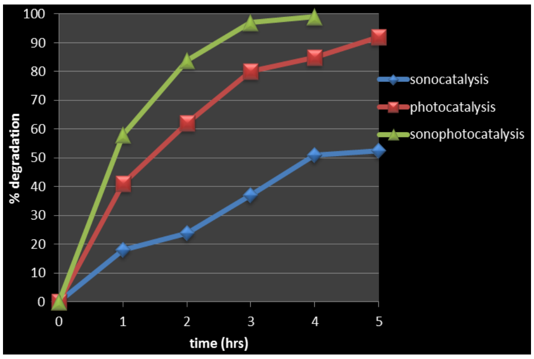

Fig4.5-comparative study between treatment

Figure shows that Sonophotocatalytic treatment achieve the maximum degradation of dye solution i.e. 99.2 % after 4 hours of reaction. The percentage degradation of dye solution by photo catalytic treatment i.e 94.5 % after 5 hours of reaction time and very less under Sonocatalytic process i.e. only 52 % after 5 hours.

The hybrid sonophotocatalysis treatment (i.e. Sonolysis + photo catalysis) with all the optimized condition like pH of 4.1, catalyst dose of 0.3gm/L and oxidant concentration of 3 ml/200ml. the superior result getting from this process i.e. 99 % degradation achieve for reactive black5 and reactive orange16 and 98.5% degradation achieve for reactive red 120 within 4 hrs.

4.6 Comparative study of hybrid sonophotochemical treatment by using sunlight and UV light.

The maximum degradation achieved in sun light is 92% after 5 hrs of reaction time and the maximum degradation achieved under UV light is 98% after 5 hours

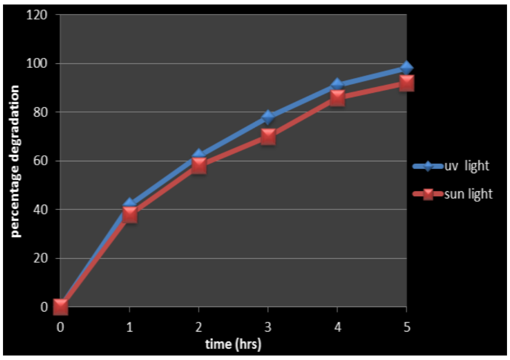

Fig 4.6 Comparative study between uv and solar light.

4.7 dye Effluent characteristics after hybrid sonophotochemical (sonophoto-cataltic) treatment.

Parameter	value (Optimized condition)
pH	7.2
COD	60-65
BOD5/COD	7.6-8.2
TSS	0
Sulphate	25
TDS	1840

Table 4.7 wastewater characteristic after treatment.

4.8 Decolorisation

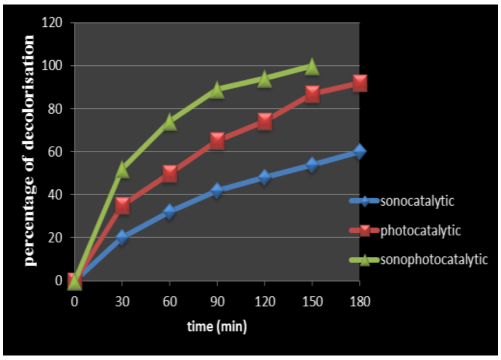

Fig 4.8 percentage of decolorisation

Complete decolorisation of azo dyes solution and textile effluent by using of hybrid sonophotochemical treatment within 150min.

5 conclusion

Hybrid sonophotochemical is a eco-friendly way to reduce the pollution from the wastewater of textile industry. So this is the new, more efficient, capable, environment friendly and cost effective technique for the successfully 99% degradation and 100% decolorization of various types of dyes and textile wastewater under solar as well as UV light. This process mineralize all toxic organic compound into non harmful chemical. the standard of initial hydrogen peroxide concentration, initial pH , the initial dye concentration and the TiO_2 catalyst concentration is a significantly affected to the rate of decolorization and rate of degradation. The overall hybrid sono-photochemical effect is greater than the additive effects sonocatalysis and photocatalysis process and show higher efficiency in the process. Using this process we can increases highly chances to reuse water again for the process.

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