WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Treatment of Textile Industry Wastewater by Using Solar Photocatalytic Process: Experimental Studies & Statistical Optimization

A. Senthil Kumar[1], A. S Ramya[2], J. Jashnavi[3], P. Nandhini[4], T.Saritha Rani[5], T.Sarthika[6], V.Saikrishna[7], B.Harshagowd[8] .

[1] *A. Senthil Kumar, Principal of Sanskrithi School of engineering.*
[2] *A.S Ramya, Head of the department in Civil Engineering Dept. Sanskrithi School of engineering.*
[3] *J.Jashnavi, Studying Final Year in Sanskrithi School of engineer.*
[4] *P.Nandhini, Studying Final Year in Sanskrithi School of engineer.*
[5] *T.Saritharani, Studying Final Year in Sanskrithi School of engineer.*
[6] *T.Sarthika Studying Final Year in Sanskrithi School of engineer.*
[7] *V.Saikrishna, Studying Final Year in Sanskrithi School of engineer.*
[8] *B.HarshGowd, Studying Final Year in Sanskrithi School of engineer.*
DOI: https://doi.org/10.55248/gengpi.234.4.38554

A B S T R A C T

The textile industry is a major source of pollution, particularly in terms of wastewater generation and discharge. The wastewater from textile manufacturing contains various pollutants such as dyes, organic compounds, and heavy metals, which can have harmful effects on the environment and human health if not properly treated. A solar photoreactor using TiO2 can be an effective method for treating textile wastewater. TiO2 can be used to catalyze the degradation of organic compounds and dyes, which are commonly found in textile waste water. In this process, the textile wastewater is pumped into a reactor vessel that contains TiO2 nanoparticles. The reactor is then exposed to sunlight, which activates the TiO2 and initiates the photocatalytic degradation of the pollutants in the waste water. The efficiency of the solar photoreactor can be improved by optimizing various factors such as the concentration of TiO2, the pH , COD & turbidity of the wastewater, and the duration and intensity of sunlight exposure . The use of a solar photoreactor with TiO2 for textile wastewater treatment has several advantages, including the low cost of TiO2, the use of renewable energy sources (i.e., solar energy), and the absence of hazardous chemicals. Additionally, this technology has the potential to be scaled up for use in larger textile manufacturing facilities.

Keywords: Catalyse Tio2, dyes & Reactor

1. Introduction

A parabolic trough reactor is a type of solar thermal power plant that uses parabolic trough-shaped mirrors to concentrate sunlight onto a receiver tube located at the focal point of the trough. The receiver tube contains a heat transfer fluid that absorbs the concentrated sunlight and transfers the heat to a working fluid, such as water or steam, which is then used to generate electricity or for other industrial applications.

The parabolic trough-shaped mirrors are typically made of highly reflective materials, such as silver-coated glass or polished aluminium, and they are designed to track the movement of the sun throughout the day, optimizing the amount of sunlight that is concentrated onto the receiver tube. The troughs are usually arranged in a long, linear configuration, with each trough measuring up to several meters in length.

The hot fluid is then used to produce steam, which can drive a turbine to generate electricity or be used for other industrial processes that require high temperatures. The PTR design is particularly well-suited for large-scale power generation applications and is often used in conjunction with thermal energy storage systems to provide a reliable and dispatch able source of renewable energy.

Compared to other types of CSP technologies, such as a tower or dish systems, PTRs have relatively low capital costs and are easily scalable, making them a popular choice for utility-scale solar power plants. However, they also have lower thermal efficiencies and require more land area to generate the same amount of power as other CSP technologies. Nonetheless, PTRs remain an important and promising technology for the development of sustainable and low-carbon energy systems.

Finally, economic considerations may drive the need for reactor replacement. As the cost of renewable energy sources like wind and solar continues to fall, nuclear power may become less competitive in the energy market. In this case, replacing an older reactor with a newer, more efficient design may be the most cost-effective way to maintain a nuclear energy supply.

2. LITERATURE REVIEW

M.A. Al-Ghouti et al (2001) [1] is determined the feasibility of using diatomite for the removal of the problematic reactive dyes as well as basic dyes from textile wastewater was investigated. Methylene blue, Cibacron reactive black and reactive yellow dyes were considered. Physical characteristics of diatomite such as pHsolution, pH_{ZPC}, surface area, Fourier transform infrared, and scanning electron microscopy were investigated. The surface area of diatomite was found to be 27.80 $m^2 g^{-1}$ and the pH_{ZPC} occurred around pH of 5.4. The results indicated that the surface charge of diatomite decreased as the pH of the solution increased with the maximum methylene blue removal from aqueous solution occurring at basic pH of around (10–11). Adsorption isotherms of diatomite with methylene blue, hydrolyzed reactive black and yellow dyes were constructed at different pH values, initial dye concentrations and particle sizes. The experimental results were fitted to the Langmuir, Freundlich, and Henry models. The study indicated that electrostatic interactions play an important role in the adsorption of dyes onto diatomite

J. Hussain et al (2016) [10] *is* analysedthe wastewater generated from textile industries of Bhilwara city is studied for its characterization. Wastewater of textile industry was found to contains a high degree of pollutants with high TDS and suspended solids. The wastewater is highly coloured and viscous due to dyestuff and suspended solids respectively. Sodium is only major cation due to high consumption of sodium salts in processing units. Chloride is major anion found in the wastewater but concentration of bicarbonate, sulphate and nitrate are also high (>100 mg/L). Sodium salts of these anions are most commonly used in the process. In heavy metal chromium is in higher concentration while other heavy metals iron, zinc, lead, copper and manganese are also present. The wastewater also has high BOD and COD indication its polluting nature.

3. OBJECTIVES

- Technical objectives: The technical objectives of PTRs include improving the efficiency and reliability of the technology. This can be achieved through the development and optimization of the mirrors, heat transfer fluid, receiver, thermal energy storage, and other components of the system.
- Economic objectives: The economic objectives of PTRs include reducing the cost of electricity generation to make it more competitive with other sources of energy. This can be achieved through economies of scale, increased efficiency, and improvements in manufacturing and installation processes.
- Environmental objectives: The environmental objectives of PTRs include reducing greenhouse gas emissions, minimizing land use, and minimizing impacts on wildlife and water resources. This can be achieved through the use of sustainable manufacturing and installation practices, and the implementation of effective environmental management plans
- Energy security objectives: The use of PTRs can help to reduce dependence on imported fossil fuels and increase energy security by providing a reliable and domestic source of renewable energy.
- Social objectives: The social objectives of PTRs include creating local jobs and stimulating economic development in the areas where they are installed. This can be achieved through the use of local Laboure and materials, and the implementation of training programs for local workers.
- Overall, the objectives of PTRs are to provide a clean, reliable, and cost-effective source of renewable energy that contributes to sustainable development and energy security while minimizing environmental impacts. By pursuing these objectives, PTRs can help to meet the energy needs of society in a way that is socially, economically, and environmentally sustainable.

A. Materials

The following materials were used in our project.

- ACRYLIC GLASSES
- PARABOLIC DISH
- COPPER PIPE
- TRANSPARENT PIPE
- 12v SOLAR WATER PUMP
- CHEMICAL -Tio2

ACRYLIC GLASSES

Acrylic glasses are glasses made from a type of plastic called acrylic. Acrylic is a popular material for glasses because it is lightweight, shatter-resistant, and can be molded into a variety of shapes and sizes. Acrylic glasses are also known for their clarity, as they are often used as a substitute for glass in applications such as windows and skylights.

PARABOLIC DISH

A parabolic dish is a type of reflective surface that is shaped like a parabola, a curve with a specific mathematical shape. It is used to collect and focus light or sound waves onto a specific point, called the focal point or focus.

COPPER PIPE

A copper pipe is a type of pipe made from copper, a metal that is ductile, corrosion-resistant, and a good conductor of heat and electricity. Copper pipes are commonly used in plumbing systems for the distribution of potable (drinking) water, as well as for heating and cooling systems, refrigeration, and industrial processes.

TRANSPARENT PIPE

A transparent pipe is a type of pipe that is made from a material that allows light to pass through it, making it possible to see the contents of the pipe. Transparent pipes are commonly used in various applications, such as aquariums, laboratories, and chemical processing plants, where it is important to visually inspect the flow of liquids or gases.

12v SOLAR WATER PUMP

A 12V solar water pump is a type of water pump that is powered by a solar panel that produces 12 volts of electricity. These pumps are typically used in remote areas where access to electricity is limited or unavailable, such as in rural areas or off-grid homes.

CHEMICAL -Tio2

TiO2 is the chemical formula for titanium dioxide, a naturally occurring oxide of titanium. TiO2 is a white, odorless, and tasteless powder that is commonly used as a pigment in paints, coatings, plastics, and other materials.

4. RESULT AND DISCUSSION

Table 4.1

S.NO/Trails	Sample	Circulating Tank	Input of water	Reactor in sunlight	Output of water	Discharge of water	Total
1	Normal water (withoutTio2)	25min	100ml	40min	96.35ml	3.65ml	96.35ml
2	Normal water (withTio2)	25min	100ml	40min	98.2ml	1.8ml	98.2ml
3	Textile water (withTio2)	30min	40min	97.4ml	2.6ml	2.6ml	97.4ml

Table4.2

Std Order	Run Order	pH	Time (hrs)	Dye concentration (mg/L)	COD % Mg/l	COLOUR REMOVAL %	TURBIDITY % NTU
1	1	5	1	3.5	66.2		3
2	2	9	1	3.5	65.4		4
3	3	5	3	3.5	66		2
4	4	9	3	3.5	67.3		1
5	5	5	2	1.0	60		4
6	6	9	2	1.0	62.5		3.2
7	7	5	2	6.0	63.7		2.5
8	8	9	2	6.0	63		3.4
9	9	7	1	1.0	67		1.3
10	10	7	3	1.0	68.90		1.5
11	11	7	1	6.0	72.6		2.5
12	12	7	3	6.0	74.3		3.9
13	13	7	2	3.5	71.5		4.1
14	14	7	2	3.5	69.5		3.5
15	15	7	2	3.5	68.6		2.4

5.CONCLUSION

The complex nature of the wastewater is the major problem in its treatment because of the presence of the complex dye groups and other poorly or non-biodegradable recalcitrant pollutants.

Textile wastewater not only consists of recalcitrant molecules but also toxic heavy metals with powerful inhibitory and antimicrobial activity.

For complete degradation and detoxification, the nature and toxicity of the recalcitrant pollutants should be explained.

Further, studies should also be conducted on the toxicity of the decolorized wastewater. Therefore, an effective treatment method is required for effluents and drinking waters to avoid their deleterious effects on humans and aquatic organisms on their exposure.

6. REFERENCES

[1] Comninellis, C.; Kapalka, A.; Malato, S.; Parsons, S.; Poulios, I.; Mantzavinos, D. Perspective Advanced oxidation processes for water treatment: Advances and trends for R & D. J. Chem. Technol. Bioethanol. 2008, 83, 769–776.

[2] Blake, D. Bibliography of Work on the Heterogeneous Photocatalytic Removal of Hazardous Compounds from Water and Air, Update Number 4 to October 2001, NREL/TP-510–31319; National Renewable Energy Laboratory: Golden, CO, USA, 2001. [Google Scholar]

[3] Arana, J.; Melian, J.; Rodriguez, J.; Diaz, O.; Viera, A.; Pena, J.; Sosa, P.; Jimenez, V. TiO2-photocatalysis as a tertiary treatment of naturally treated wastewater. Catal. Today 2002, 76, 279–289. [Google Scholar] [CrossRef]

[4] Al-Bastaki, N. Performance of advanced methods for treatment of wastewater: UV/TiO2, RO and UF. Chem. Eng. Process 2004, 43, 935–940. [Google Scholar] [CrossRef]

[5] Likodimos, V.; Dionysiou, D.; Falaras, P. Clean water: Water detoxification using innovative photocatalysts. Res. Environ. Sci. Biotechnol. 2010, 9, 87–94. [Google Scholar] [CrossRef]

[6] Dimitroula, H.; Daskalaki, V.; Frontistis, Z.; Kondaides, D.; Panagiotopoulou, P.; Xekoukoulotakis, N.; Mantzavinos, D. Solar photocatlysis for the abatement of emerging micro-contaminants in wastewater: Synthesis, characterization and testing of various TiO2 samples. Appl. Catal. B: Environ. 2012, 117, 283–291. [Google Scholar] [CrossRef]

[7] Miranda-Garcia, N.; Maldonado, M.; Coronado, J.; Malato, S. Degradation study of 15 emerging contaminants at low concentration by immobilized TiO2 in a pilot plant. Catal. Today 2010, 151, 107–113. [Google Scholar] [CrossRef]

[8] Agullo-Barcelo, M.; Polo-Lopez, M.; Lucena, F.; Jofre, J.; Fernandez-Ibanez, P. Solar advanced oxidation processes as disinfection tertiary treatments for real wastewater: Implications for water reclamation. Appl. Catal. B: Environ. 2013, 136, 341–350. [Google Scholar] [CrossRef]

[9] Dominguez-Espindola, R.; Silva-Martinez, S.; Ortiz-Hernandez, M.; Roman-Zubillaga, J.; Guardian-Tapia, R. Photocatalytic disinfection of municipal wastewater using TiO2 film and Ag/TiO2 powder under UV and solar light irradiation. Mex. J. Sci. Res. 2013, 2, 60–68. [Google Scholar]