International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 06 | Jun 2024 www.irjet.net p-ISSN: 2395-0072

Waste Water Treatment By Advanced Oxidation Processes

Kartik Porwal[1], Dr. Nitesh Parmar[2], Dr. Rajesh Kaushal[3]

[1]MTech Student, RGPV University, IPS Academy, Indore
[2]Assistant Professor, Department of Chemical Engineering, IPS Academy, Indore, M.P.
[3] Head of Department, Dept. of Chemical Engineering, IPS Academy, Indore, M.P.

Abstract – *Advanced oxidation processes (AOP) has offered the best solution in treatment of pharmaceutical wastewater. It has investigated on the efficacy of AOPs in degrading the water with the use of Titanium di oxide (TiO_2) nanoparticles. It has synthesized through sol-gel method and evaluating the study with the parameters catalyst dosage, irradiation time, temperature, pH and degradation efficient with effective results. It has underscored on the organic pollutants with optimal conditions and achieving higher degradation rates in sustainable treatment of wastewater and environmental remediation*

Key Words: *Advanced Oxidation Processes, Wastewater Treatment, Pharmaceutical Wastewater, Titanium Dioxide Nanoparticles, Sol-Gel Method, Photocatalytic Degradation, Catalyst Dosage, Irradiation Time, Temperature, pH, Organic Pollutants*

1.INTRODUCTION

The need of water is raised due to efficient factors like expanding agriculture, industrialization and raising population. It has traditionally manage the water collection methods using reservoirs, wells and alternatives like recycling and desalination. It has been predicted that water scarcity would be caused due to contamination of the water in regions leading to water pollution. It will excessively deplete oxygen and harming the aquatic environment which are leading to detrimental effects on the aquatic ecosystem.

TiO_2 has emerged to be promising technique which can help in extensive use of the environmental application. It has finally aim on sol-gel method to offer a control on the particle size and crystallinity. It has degraded on the organic pollutants in the pharmaceutical wastewater.

1.1 METHOD OF SYNTHESIS OF NANO-PARTICLES

The Nano-particles have synthesized using various methods including sol-gel, chemical vapor deposition, physical vapor deposition, bottom-up techniques like nucleation and growth of particles. However, sol-gel method turns out to be more effective as it is utilizing the hydrolysis and condensation of precursor molecules with colloidal suspension. It has violated on the molecules and then dried to form nano-particles.

2. LITERATURE REVIEW

Various articles, journals and thesis are conducted on the topic but extensive use of TiO_2 nano particle in precise can be analyzed with the base for the reviews that are undertaken in the study.

Table -1: Literature Review

Author	Year	Focus
Vassilios Binas et al	2019	Investigated on the degradation of sulfamethoxazole using iron-doped titania under simulated solar radiation
Muh et al	2018	Explored on the preparation of natural biopesticides as a antimicrobial material through lignin photodegradation using mineral ilmenite
Xiaodong et al	2018	Examined the enhancement of Raman scattering using substrates of titanium oxide nanorods coated with gold nanoparticles
Yu Niu et al	2018	Analyzing the efficiency of photocatalytic hydrogen production using TiO_2 photocatalyst in aqueous solution of methanol

Similarly, other authors have also focused on the synthesis of titanium dioxide for encapsulating it into the potential application of it. The use of Trigonella foenum-graecum extract, fabricated Alcea and thyme stabilized TiO_2 nano particles have highlighted on the potential application of environmental remediation.

3. EXPERIMENTAL SET-UP

The experimental set up for thin-film based photocatalytic reactor is designed using kinetic studies by minimizing the scattering of the energy intensity with suitable pseudo-Beer-Lambert law application.

Chart -1: Front View of Setup in Operating Condition

It has continuously operated for 2 hours at the flow rate of 4 liters/hr under 100 W/cm^2 UV source, the performance of the reactor was evaluated through following parameters.

Chart -2: Reactor Under Sunlight

The pH and chemical oxygen demand (COD) have been used in the standard method. It has involved the oxidizing organic matter, pH which was electrometrically managed. It has also done the catalyst dosage with the effluent concentration, irradiation time, temperature and pH. It can remark that optimal conditions are 10:1 effluent-to-water ratio, a 0.8g catalyst dosage, 1 hour irradiation at 35^{0}C temperature and ensuring OH* in radical form to facilitate effective degradation of photocatalytic pollutants in the waste water.

4. RESULT AND DISCUSSION

The characterization of TiO_2 nanoparticles have synthesized the sol-gel route shows for the crystalline structures with 2 θ distinct peaks indicated in the anatase phases.

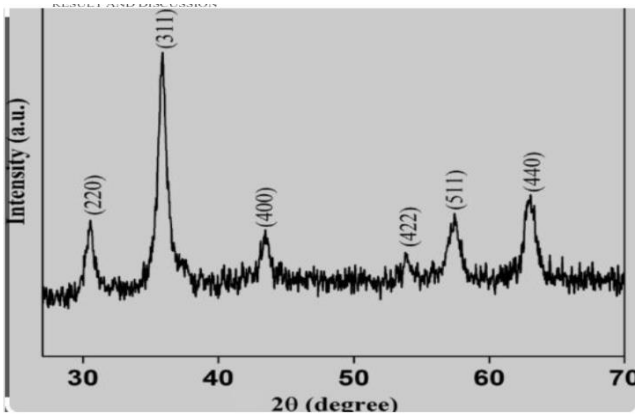

Fig -1: XRD pattern of TiO2 nanoparticles synthesized via sol-gel route

The use of Debye-Scherrer's formula at 7nm has represented the SEM images which reveal on the optimal usage of the pharmaceutical waste water treatment.

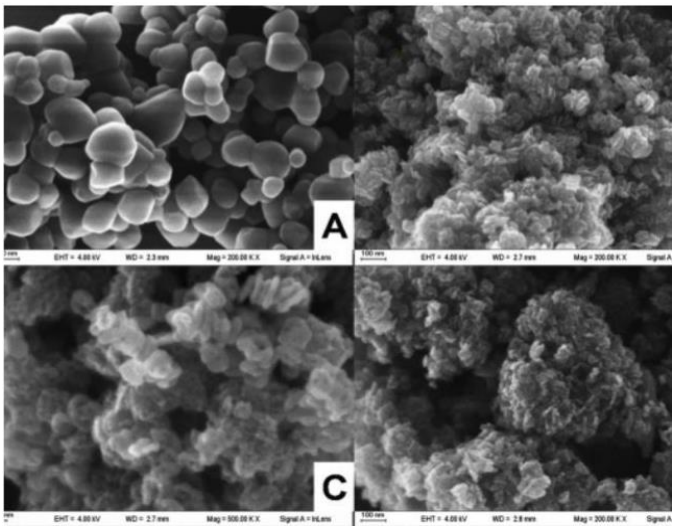

Fig -2: SEM micrographs of TiO2 nanoparticles synthesized via sol-gel route

The optimal use of UV-vis absorption spectra has added on crystalline size and achieving the different photocatalytic performance of wastewater.

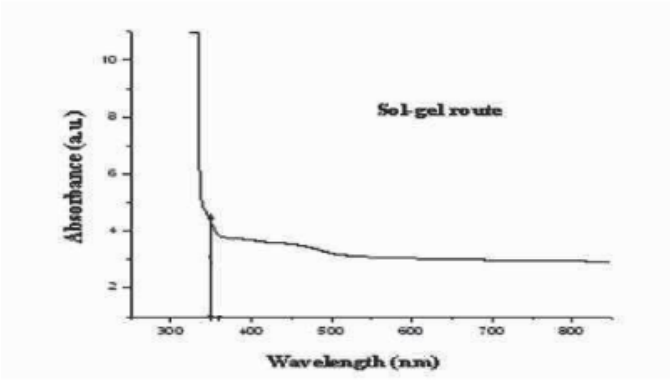

Fig -3: UV-vis absorption spectra of TiO2 nanoparticles via Sol-gel route

The treatment of the wastewater has added on the radiation of catalyst dosage to be 80mg, achieving 90% degradation efficiency.

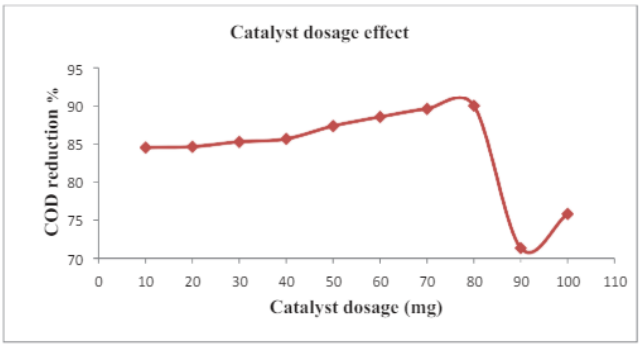

Fig -4: Effect of dosage on photocatalytic degradation efficiency of organic pollutants

This has raised the increase in the dosage beyond the reduced efficiency due to UV light intensity interference.

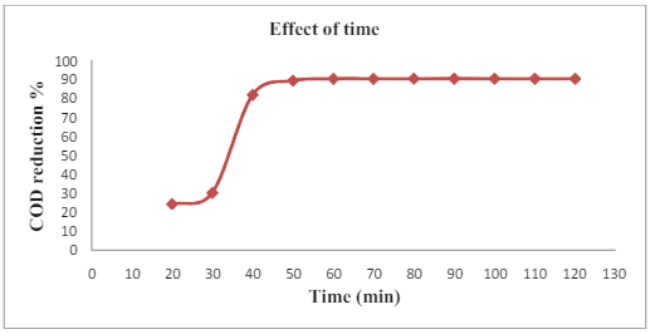

Fig -5: Effect of irradiation time on the photocatalytic degradation efficiency of organic Pollutants

The irradiation time has significantly influenced the degradation with 91.08% efficiency at 60 minutes time. It can present the sharp increase in the time and attribute to the organic pollutants with raised waste molecules in the activated surface of TiO_2.

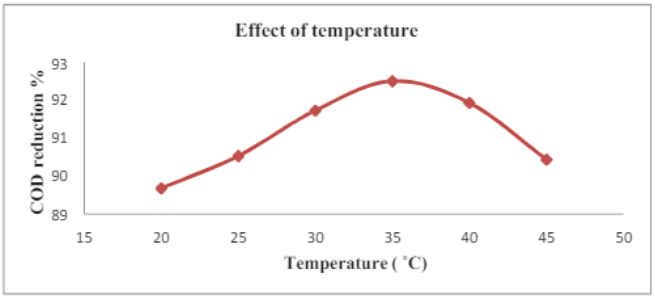

Fig -6: Effect of temperature on the photocatalytic degradation efficiency of organic Pollutants

The reaction temperature is likely to raise the photocatalytic activity which can present the optimum concentration within 100 ml effluent solution and optimal dosage of 0.8g. it has varied temperature and removing 92.07% COD degradation removal at 35^0C.

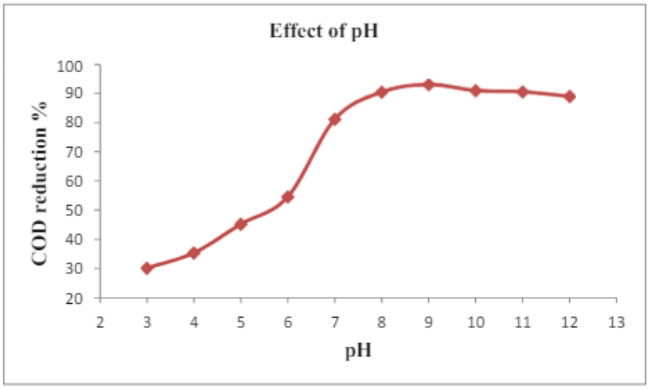

Fig -7: Effect of pH on the photocatalytic degradation efficiency of organic Pollutants

At high pH, the effective time will attract the cation to the surface and influencing the estimate effect of pH on the COD removal in the wastewater. It has minimal impact and adding optimal degradation at pH 9 and achieving 93.06% efficiency. It has underscore the importance of optimizing catalyst dosage using TiO_2 nano particles.

5. CONCLUSIONS

Photocatalysis has remark on the treatment of the water with the decomposition of organic compounds. Photocatalytic degradation is a promising technology which instigate on the transformation of ambient conditions with the extensive presence of pesticides, herbicides, and micro pollutants. It has also scale up with the results and use of

TiO_2 with the wastewater treatment. The result has optimized the process parameters with optimum catalyst dose of 80 mg/ 100 ml for irradiation time of 1hr under continuous stirring with maximum intensity and pH of 9 and temperature at 35^0C. In future, it can commercially scale the possibility of viability of AOP in the industry.

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