Methods

Benemérita Universidad Autónoma de Puebla

PHOTODEGRADATION OF CONTAMINANTS IN RESIDUAL WATER THROUGH SYNTHETIZED CATALYSTS OF ZnO/TiO_2

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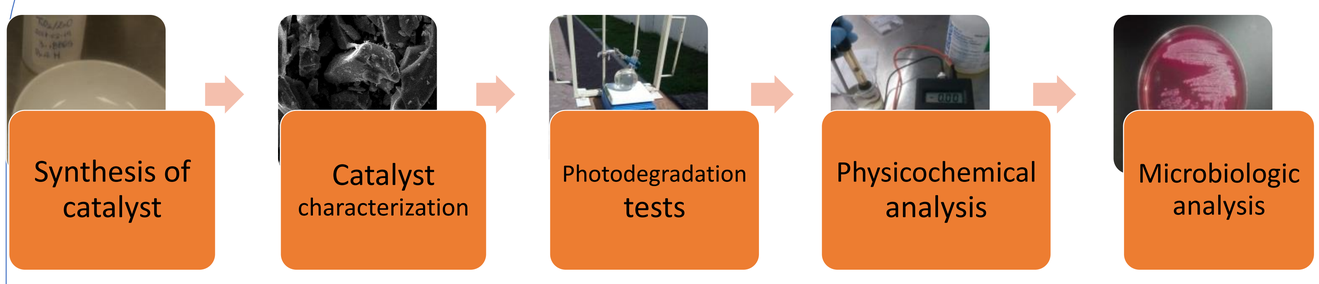
Introduction

Most Puebla wastewater treatment plants have only advanced primary treatment; this does not guarantee that all organic contaminants and microorganisms, especially pathogens, will be eliminated by this treatment. Since the quality of wastewater originating in the city of Puebla exceeds the permissible limits established by Mexican regulations, it is necessary to adopt strategies that improve the quality of effluents at a low cost. A viable alternative for the elimination of these water pollutants, both for their efficiency and for their low cost, is the use of ultraviolet radiation from the sun, which is why it was decided to use heterogeneous photocatalysis as a method of degradation of pollutants in the wastewater from Puebla, Mexico.

Methods



The sol-gel method was selected using Titanium Tetrabutoxide, ethanol, acetic acid, deionized water, zinc nitrate and diethanolamine as precursors according to the methodologies [1,2]. The catalyst was characterized by XRD and SEM techniques.

Degradation tests were carried out in a solar reactor made of borosilicate, with 95% UV transmission and 1 L capacity. 0.03 g of the catalyst was required and it was kept in contact with solar radiation for 5 hours. Every hour an aliquot of the sample was taken and analyzed in a Perkin Elmer Lamda 20 UV spectrophotometer.

Before and after the degradation tests, physicochemical analysis was carried out in order to compare the values with the Mexican regulations. In addition, microbiological analyzes were also carried out to quantify and identify the main microorganisms present in the wastewater before and after the photochemical treatment..

Discussion

The ZnO/TiO_2 catalyst combined with solar radiation obtained favorable results as it succeeded in reducing the concentration of contaminants until permissible levels by the applicable Mexican regulations. In the fig. 1 peaks with greater intensity in 2θ = 25°, 39°, 48°, 54° and 63°, are characteristic of the TiO_2 anatase but widening of the peaks indicates that ZnO was incorporated into the structure of TiO_2. The fig. 2 shows an irregular polygonal geometry. In the fig. 3 shows we can clearly see a decrease in absorbances, which indicates that the degradation of pollutants is taking place successfully. Tables 1 and 2 show the physicochemical and microbiological values before and after the photochemical treatment, in both cases the values were considerably reduced and the organisms were inactivated.

Results

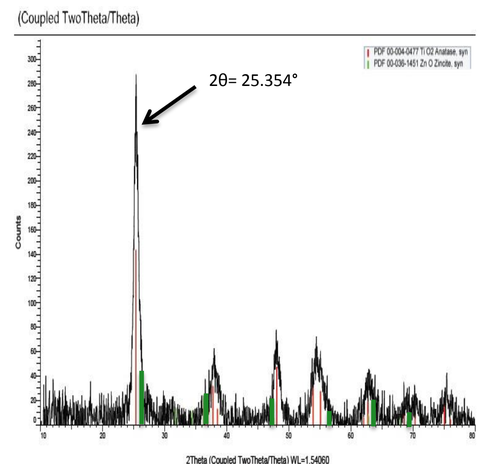


Fig. 1. ZnO/TiO_2 catalyst diffractogram.

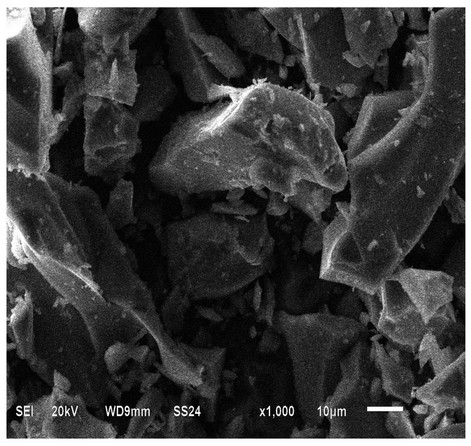


Fig. 2. Micrograph of the ZnO/TiO_2 catalyst at 1000X.

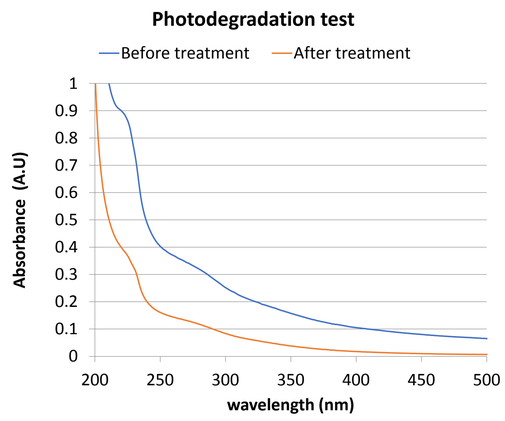


Fig.3 UV-VIS spectrum of wastewater before and after photochemical treatment with solar radiation

Table 1. Results of physicochemical analyzes

Parameter	Before treatment	After treatment
pH	7.67	8.05
Temperature	22.2 °C	25.2 °C
Sedimentable solids	5.0 mg/L	2.0 mg/L
Total suspended solids	636.0 mg/L	92.0 mg/L
COD	360.0 mg/L	110.0 mg/L
BOD_5	245.0 mg/L	66.0 mg/L
Turbidity	44.0 NTU	3.0 NTU
Color	7.0 m^{-1}	1.2 m^{-1}

Table 2. Quantification and microbiological identification

Bacterium	Before treatment	After treatment
Escherichia coli	x	x
Enterobacter	x	
Klebsiella	x	
Pseudomonas	x	x
CFU/mL	3.6×10^8	16,300

Conclusions

The conventional catalysts in this type of processes are those of TiO_2, however, it is intended that when combined with ZnO a greater efficiency is obtained in the degradation of contaminants as well as the inactivation of microorganisms. The catalysts evaluated in this research represent a viable option for the treatment of wastewater, which translates into a reduction in the impact on the environment and a lower cost in the treatment of wastewater.

Literature Cited

{1} Khairy, M., & Zakaria, W. (2014). Effect of metal-doping of TiO2 nanoparticles on their photocatalytic activities toward removal of organic dyes. *Egyptian Journal of Petroleum, 23*, 419-426.

{2} Moradi, S., Aberoomand-Azar, P., Raeis-Farshid, S., Abedini-Khorrami, S., & Hadi Givianrad, M. (2016). The effect of different molar ratios of ZnO on characterization and photocatalytic activity of TiO2/ZnO nanocomposite. *Journal of Saudi Chemical Society, 20*, 373-378.