Photocatalytic treatment of wastewater with an energy autonomous and portable pilot unit

M. V.Karavasilis[1,2],I. Manariotis [3] , A. Sougias[4], D.Varvitsiotis[4], C D.Tsakiroglou[1,*]

[1] Foundation for Research and Technology Hellas, Institute of Chemical Engineering Sciences, Stadiou str, Platani, 26504 Patras, Greece

[2] University of Patras, Department of Chemistry, 26504 Patras, Greece

[3] University of Patras, Department of Civil Engineering, 26504 Patras, Greece

[4]ECOVAR POWER OE, B3 Block 31A, Patras Industrial Area (VIPE)-Ag. Stefanos, 25200 Patras

* ctsakir@iceht.forth.gr

ABSTRACT

The degradation of the water quality remains in the top of the global environmental problems [1], [2], and the development of sustainable and cost-effective methods for its treatment is a great challenge for. The photocatalytic treatment of wastewater is a well promising advanced oxidation process for the degradation of organic substances and pathogens [3], [4]. Zinc-oxide (ZnO) nanoparticles were immobilized on Duranit (80% silica+ 20% alumina) inert balls with immersion in aqueous solution of zinc acetate dehydrate at 80°C for 30 min, separation of spheres, and and heating at 4 temperatures ramps (80°C, 110 °C, 140 °C and 430°C) for 2 hrs per each one. Complete characterization of the materials surface was done by a variety of techniques (SEM, UV-Vis, RAMAN, XRD, Photoluminescence). An energy-autonomous and portable pilot unit was designed and manufactured. The unit was placed on a wheelbarrow and consisted of a photovoltaic panel, four (4) metalic reactors ,two (2) peristaltic pumps (power=5 W), an external recirculation tank, and a magnetic stirrer (power=5 W). The reactors were filled with ZnO-coated Duranit spheres, and each two of them were connected in series and parallel. First, the oxidation efficiency of phenol in aqueous solutions was studied. Continuous flow experiments were performed by varying the initial concentration of the phenol and the injection rate of aqueous solution. Samples of aqueous phase were collected occasionally from the recirculation tank and phenol concentration was measured with UV-Vis spectrometry by using the the 4-aminoantipyrine method. Second, the effluents collected from the outlet of the Wastewater Treatment Plant of the University of Patras were used as real wastewater. A series of physicochemical analyses (TOC, COD, pH, ORP, NO_3^- NO_2) were carried out to elucidate the effects of photocatalysis on the quality of treated water. All experiments initiated early in the morning and stopped at sunset, whereas the the photovoltaic panel was oriented in the south direction, thus maximizing the utilization of solar radiation. The results of the pilot experiments allowed us to assess the applicability of such systems as portable units for the treatment of wastewater and supply of pure water over off-grid regions.

KEYWORDS: Photocatalysis, Zinc Oxide, Autonomous pilot

REFERENCES

[1] *"Water Pollution Remains Top Environmental Concern in U.S." https://news.gallup.com/poll/347735/water-pollution-remains-top-environmental-concern.aspx (accessed Jan. 07, 2022).*

[2] "Water pollution is an increasing global concern | UN-Water."

https://www.unwater.org/water-pollution-increasing-global-concern/ (accessed Jan. 07, 2022)

[3] M. V. Karavasilis and C. D. Tsakiroglou.(2021). Can. J. Chem. Eng. doi: 10.1002/cjce.24199.

[4] M. V. Karavasilis, M. A. Theodoropoulou, and C. D. Tsakiroglou. (2021). Nanomaterials, vol. 12, no. 1, p. 69. doi: 10.3390/nano12010069