AFRICA JOURNAL OF PHYSICAL SCIENCES

Electrocatalytic Reduction and Characterization of Tetrachlorvinphos in Acetonitrile-Water (1:1) Media in Presence of Cyanocobalamin

Zachary Njiru Nkunu[1,a], Peterson Momanyi Guto[1,b], Joyce Gatiiria Kithure[1,c]

[1]Department of Chemistry, University of Nairobi, P.O Box 30197 - 00100, Nairobi, Kenya

[*a]nkunuzach@gmail.com, [b]Peterson.guto@uonbi.ac.ke, [c]jkithure@uonbi.ac.ke

ARTICLE INFO

Article History:
Available online: 00 00 00

Keywords:
Electro-reduction;
Cyanocobalamin;
Tetrachlorvinphos;
Cyclic voltammetry.

ABSTRACT

This work seeks to investigate a possible electrocatalytic degradation of tetrachlorvinphos pesticide in acetonitrile-water media using cyanocobalamin as the catalyst. The catalyst and its derivatives are employed in some organic synthesis due to their ability to form and selectively cleave Co-C bonds. There is inadequate data from previous related works. This study explores possible electrocatalytic route for degradation of tetrachlorvinphos using the catalyst at temperature of 24 ± 1° by cyclic voltammetry method. Tetrachlorvinphos exhibited two consecutive reduction peaks at ~-0.710 ± 0.004 V and ~ -1.096 ± 0.029 V Versus Ag/AgCl. The second reduction peak registered a diffusion coefficient value of 3.68 x 10^{-5}cm^{2}s^{-1} and current density of be 5.83 x 10^{-5} A/cm^2. The reduction potential for tetrachlorvinphos in presence of cyanocobalamin was observed to be -0.923 ± 0.03 V versus Ag/AgCl. The diffusion coefficient and current density value was reported at 3.37 x 10^{-5} cm^{2}s^{-1} and 2.56 X 10^{-5} A/cm^2 respectively for an electro-reduction process. This implies that, catalytic reduction of the pesticide occurred at a significantly lower potential compared to direct reduction. The over potential saving of about 0.168 V is an indication of the catalyst efficiency on the pesticide degradation.

1. Introduction

Organophosphates (OPs) are usually esters, amides or thiol derivatives of phosphoric, phosphonic, or phosphinic acids. OPs are applied as pesticides and insecticides in agriculture and as chemical warfare agents in military practice. OP compounds worldwide account for over about 40% of the total pesticides used [1]. Most used organophosphates include parathion, Malathion, methyl parathion, chlorpyrifos, diazinon, dichlorvos, phosmet, fenitrothionazinphos methyl and tetrachlorvinphos. Malathion is commonly used in public health pest control programs such as mosquito eradication [2]. Tetrachlorvinphos is an organophosphate cholinesterase inhibitor that is used as an insecticide [3]. It is registered for use in Canada, South Africa, and Australia, as well as in the USA [4]. In 1966, it was registered for use in the United States by the United States department of Agriculture on various food crops, livestock, pet animals, and in or around buildings and later banned in 1987 [4]. However, in many African countries including Kenya, its use is evident especially in public health works [5]. Tetrachlorvinphos is a white crystalline powder [8], mild color, odor [9] and when heated to decomposition it emits toxic fumes of hydrogen chloride and phosphorous oxides [10]. It has low solubility, volatility and strong affinity to colloidal matter [6]. In the environment, tetrachlorvinphos primary route of dissipation is through biotic degradation. Under alkaline conditions, abiotic processes such as hydrolysis, photo-degradation and biodegradation are somewhat efficacious [7]. Tetrachlorvinphos is relatively toxic to pets and livestock [11]. Humans can be exposed to Tetrachlorvinphos when treating pets or through dermal contact with pets treated with pet collars, powders, or aerosol sprayers [3]. Symptoms of