Mathematical Modeling of pH-Based Potentiometric Biosensor Using Akbari-Ganji Method

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Received: 8 December 2021 / Accepted: 22 January 2022 / Published: 2 February 2022

This study discusses a mathematical model for the steady-state reaction of a pH-based potentiometric biosensor immobilizing organophosphorus hydrolase (OPH). The model that combines diffusion and enzymatic reaction processes in the membrane is a system of five interconnected nonlinear reaction-diffusion equations. Approximate analytical expressions for the substrate concentration (organophosphorus pesticides (OPs)) and products are derived for all possible values of Thiele modulus and buffer concentration using the Akbari-Ganji method. In addition, analytical expressions for the current, sensitivity, and resistance of pH-based potentiometric biosensors are also derived. The obtained analytical results are convergent on the prescribed domain and firmly match the fourth-order Runge-Kutta numerical simulations.

Keywords: Mathematical modeling, reaction-diffusion, pH-based potentiometric biosensor, Akbari-Ganji method, nonlinear equations.

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