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INFLUENCE OF THE EXTERNAL FACTORS ON THE REPRODUCIBILITY OF THE BIOSENSOR RESPONSE

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Behaviour of electrochemical glucose biosensor, based on glucose oxidase was examined in diffusion and kinetic modes of action. Mathematical model based on enzymatic conversion of substrate and diffusion of substrate was created and influence of fluctuations of membrane thickness, diffusion coefficients and pH were modelled.

Biosensors as an analytical instrument have found wide application in medicine, environment, and food-quality control. However, application of the biosensors is limited by low reliability of the biosensor action. This is due to a number of diffident parameters. Stability of the biosensor action depends on both: stability of the sensing element of the biosensor - usually enzyme or enzymatic complex, and stability of the matrix. Complicated construction of the biosensor, usually consisting of several semi-permeable layers very often is sensitive to the fluctuations of the pressure in the bulk, especially in flow-through conditions. Fluctuations of the pH, or concentration of salts can change diffusion parameters of the biosensor membranes, thereby, changing the response of the biosensor. The main goal of this paper is mathematical modelling and evaluation of the influence of three main parameters of the biosensor - pH, membrane thickness and diffusion fluctuations.

Suppose that substrate (S) conversion to product (P) was catalysed by the enzyme (E).

$$S \xrightarrow{E} P.$$

Consider biosensor as a flat amperometric device with a layer of enzyme and outer membrane. It follows that the model has two regions. In the first region (outer membrane) only mass transport limited by diffusion takes place. In the second region (enzyme layer) enzymatic conversion of glucose to gluconic acid, oxygen to hydrogen peroxide and mass transport are limited by diffusion. A mathematical model of biosensor is based on system of diffusion equations with a nonlinear term corresponding to Michaelis-Menten kinetic of the enzymatic reaction together with boundary and initial conditions and compatibility conditions on the boundary between two regions with different diffusion coefficients.

In this study we demonstrated mathematical model, allowing predict reproducibility of the biosensor and evaluate influence of membrane thickness, diffusion coefficient and pH on metrological parameters of biosensor.