Developing a conductometric biosensor to analyze formaldehyde in an aquatic environment

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Introduction

Formaldehyde is one of the most important chemical products in the world. It is mainly used as a raw material. This compound is also found in all life forms, including humans. Despite its natural existence in the human body, it represents a danger because of its toxicity and its carcinogenicity, at a certain concentration. Therefore, it is important to detect and quantify this pollutant. In this work, a biosensor based on formaldehyde dehydrogenase enzyme (FDH) was developed to determine the formaldehyde in an aquatic environment by conductometry. This technique is an attractive alternative to conventional methods of analysis. It allows rapid detection of a biochemical change in a sample and converts it into an usable signal

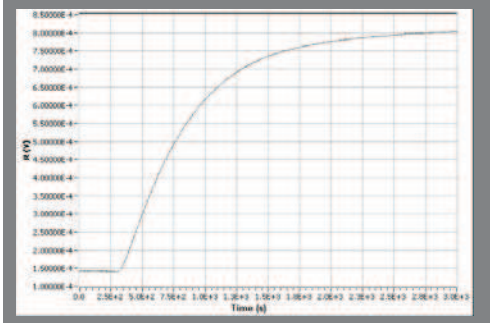
Experimental methods

Analyses were performed using a biosensor prepared in the laboratory. The biosensor was constructed by immobilizing FDH on gold microelectrodes. Then, it was immersed in a 5 mM phosphate buffer solution at pH 7 containing nicotinamide adenine dinucleotide (FDH cofactor). FDH substrate, formaldehyde, was then injected into the solution and its conductance was measured using a conductometric system (graph 1). Measurement parameters were : input voltage of 10 mV, a frequency of 100 kHz generator, an alternating current and a circuit resistance of 100 Ω.

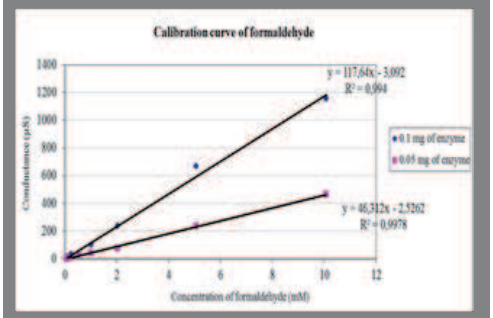
Results and discussion

The influence of different parameters, such as formaldehyde, FDH, cofactor and phosphate buffer concentrations, was studied. The biosensor response was linear in the 0.02 to 10 mM range of formaldehyde, whatever the enzyme concentration (graph 2). The increase of FDH improved the signals. The study of the cofactor concentration between 20 and 100 mM showed its low influence on the signal. Therefore, it was more interesting to work at a low concentration, that is to say 20 mM. Finally, the concentration of phosphate buffer was studied from 1 to 10 mM. A significant decrease of conductance together with an increase of analysis time was observed at higher phosphate concentrations. Therefore, a 5 mM solution was selected.

Graph 1 : Typical enzymatic response obtained after formaldehyde injection



Graph 2 : Influence of enzyme and formaldehyde concentrations on the biosensor response



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