NEW TOOLS FOR THE ON-SITE DETECTION OF WATER POLLUTANTS: ION-SELECTIVE ELECTRODES AND LATERAL FLOW DEVICES

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INTRODUCTION

The occurrence and fate of pharmaceutical contaminants in water is a complex and important topic which is directly related to the environment and human health. A wide range of different pharmaceuticals are released in the environment, either direct or indirect. The most common way of these substances in the environment is via excretion or disposal (Fig.1). Depending on their structure and reactivity they are only slowly transformed or can even remain unchanged due to their persistence. The most common way for the quantification of different contaminants are chromatographic based methods such as GCMS and LCMS. The aim of this work was the development of ion-selective electrodes and lateral flow devices (LFDs), as economic and fast tools for the on-site determination of different pharmaceutical residues.

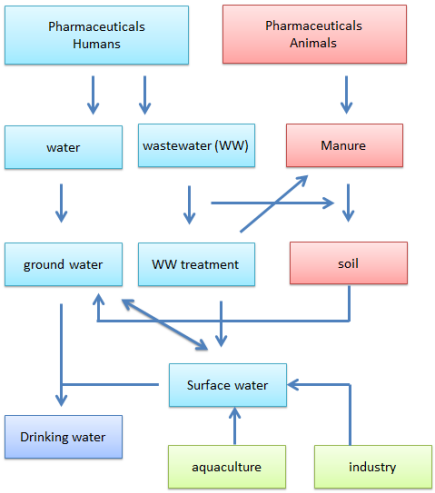

Figure 1. Distribution of pharmaceutical active compounds in water

Antipyrine and metamizole (Fig.2) were chosen as target analytes since both molecules are nitrogen containing pollutants, which makes their detection via metallacarborane complexes possible. Metamizole is an analgesic and antipyretic drug and has anti-inflammatory effects. It is a pro-drug which breaks down after oral administration to structurally related compounds like Antipyrine.

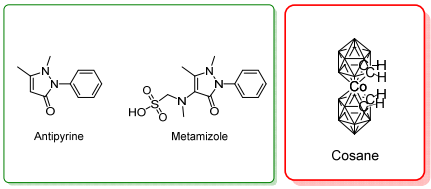

Figure 2. Target molecules (left) and cosane, which was used for the complex synthesis

BACKGROUND

The most important part of an ion selective electrode is the membrane, which is responsible for its sensitivity and selectivity. The developed and optimized membrane consists of three core parts, which are: polymer matrix, plasticizer and ionophore. The ionophore is an ion pair complex formed between analyte and carborane (Fig.2). The characterization of the electrodes was done in a classical two electrode setup using a reference electrode and the prepared working electrode (Fig.3). The performance of the ISEs were characterized by their detection limit and slope of the calibration curve.

Lateral flow devices (LFDs) are commonly used for testing concentrations of different drugs, biomarkers or other target molecules in different media and are a valuable alternative approach for

the detection of pollutants in low concentrations. The most prominent example of this technique is the standard pregnancy test, which indicates pregnancy by showing two purple lines. The huge advance of LFDs is their portability and easiness.

RESULTS AND DISCUSSION

Based on recent results in comparable experiments [1,2] a similar membrane composition was used and optimized in order to achieve a good selectivity and long-term stability. The best results were achieved with a membrane composition of 4.0 wt% ion-pair complex, 33 wt% PVC and 63 wt% plasticizer. A serial dilution of each analyte was measured, three times with each electrode, from lower to higher concentrations and the obtained values were plotted against the signal. Based on the obtained data it was possible to evaluate the limit of detection (LoD), linearity/working range, slope, stability and the reproducibility (Fig.3).

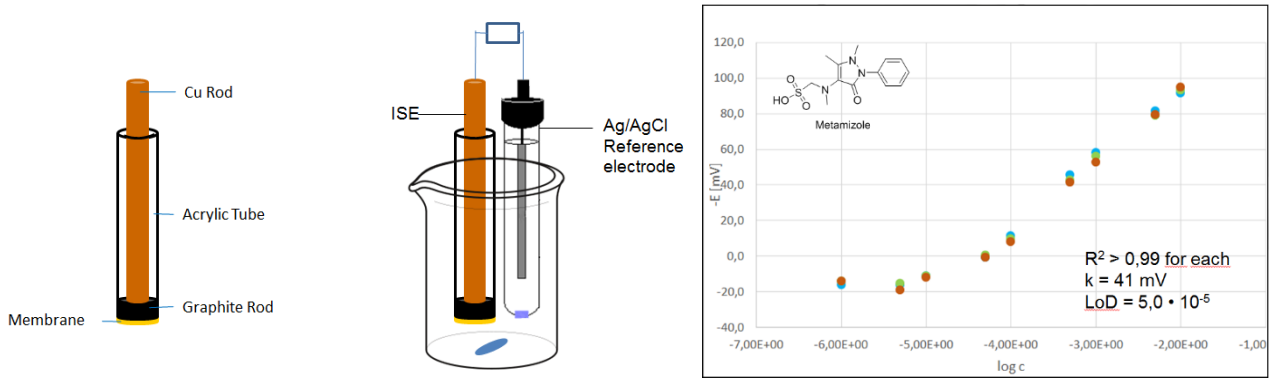

Figure 3. Experimental two electrode setup (left) and the obtained results for metamizole.

Beside the analytical parameters, the developed electrodes are robust and can be stored and re-used during a period of months. This demonstrates the capability of the developed electrodes to be used under harsh on-site conditions. Although there is still room for improvement regarding the slope, composition and linear range, it was demonstrated that it is possible to sense the target analytes with cosane based ion-pair complexes. The results further demonstrate the usability of the developed simple and cost-effective electrodes which provide a rapid response and shows a good reproducibility.

Beside the ion-selective approach, an additional focus was the development of a lateral flow device for metamizole, in order to provide a complementary system for the detection of the proposed target analytes. First results are really promising and will be presented in detail during the symposium.

OUTLOOK

Within the future, the detection limit of the electrodes should be improved in order to reach a limit of detection below 10^{-6} mol/L. Beside this, a lateral flow device with an even higher sensitivity as an alternative quantification method will be developed.

ACKNOWLEDGEMENT

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