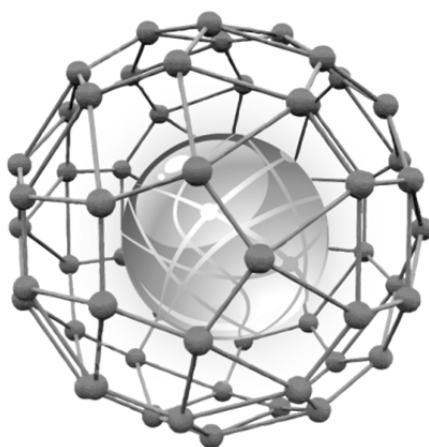МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ
НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
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ПОЛИФУНКЦИОНАЛЬНЫЕ ХИМИЧЕСКИЕ МАТЕРИАЛЫ И ТЕХНОЛОГИИ

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ЦВЕТОМЕТРИЧЕСКОЕ ОПРЕДЕЛЕНИЕ РОДАМИНА И ЭОЗИНА В НЕФТЯНЫХ МЕСТОРОЖДЕНИЯХ

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COLORIMETRIC DETERMINATION OF RHODAMINE AND EOSINE IN OIL-WATER RESERVOIR

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Relevance of the work is the detection limits of the method enables the simultaneous detection of rhodamine and eosine used as water or water-oil tracers in large reservoirs.

The main aim of the study: Determination of the rhodamine and eosine with a simultaneous separation from the sample matrix, choosing the right sorbent material is a very important step. The PMM is organic polymer, theoretically the protonated and the deprotonated molecules can be used for extraction.

The methods used in the study: colorimetric analysis

The results: Dyes were enriched out of 50 mL sample and extracted with 1 plate of PMM. The volume ratio results into an enrichment factor 380. Extraction efficiencies of dyes were determined by comparing after SPE of water and oil-water samples containing 2 mg/L of each. The accuracy and precision of the results of the determination of the test components were verified by the standard addition method.

Key words: rhodamine, eosine, oil reservoir, trace monitoring, ecology.

Rhodamine and eosine are suitable water tracers in oil reservoirs, ground and soil water studies [1, 2]. Currently this dyes are tested as indicators in leaching studies for carbon sequestration techniques. The main advantage of xanthene dyes are due to their similar chemical and physical behavior and their large number the possibility of conducting several simultaneous studies at the same reservoir or location without interference [3, 4]. Because of high dilution in large reservoirs and high cost for most of the tracers, enhancing their detection limits is still of great importance. Because of the high salinity and organic compounds in samples of oil reservoir studies, capillary electrophoresis and HPLC–UV are less suitable techniques for determination at trace level due to unwanted interferences in detection or separation [5–8]. Therefore not applicable for a selective solid phase extraction of xanthene dyes from highly saline reservoir samples. The detection limits of the method described in this paper enables the simultaneous detection of rhodamine and eosine used as water or water-oil tracers in large reservoirs.

The interactions between dyes and the immobilized in PMM reagents were studied by solid-phase spectrophotometry under batch conditions [9]. For this purpose, reagent was put into 50.0 mL of an analyte solution of different concentrations and pH and stirred with PMM for 5–30 min (Fig. 1,2). After that absorption spectra or absorbance of PMM was measured. Besides, visible color changes of PMM were estimated with digital imaging by means of a scanner. The PMM image was captured and transferred to a computer and the color was interpreted using imaging software where the colorimetric data in RGB format were related to the concentration of the dyes [10, 11].

With regard to the adsorption of adsorbates on synthetic polymeric adsorbent PMM in water and water-oil solution, hydrophobic interaction is usually considered to be a dominant driving force. When the adsorbates are not easily water-soluble, the adsorption will be significantly reduced because of the polarity mismatching between the adsorbates and the polymeric matrix.

The working curve of the spectra absorbency of the standard rhodamine and eosine solution with different known concentrations was firstly measured, and two well fitted regression equations, $A = 0,23C+0,04$ (for rhodamine) and $A = 0,07376C$ (for eosine), were achieved with the correlation coefficient R higher than $0,999$ in diapason $0,05–50$ mg/L . The absorbency of the rhodamine and eosine solution adsorbed by PMM was measured and the equilibrium concentration, was calculated based on the working curves.

For separating analytes from interfering sample matrices and for simultaneous preconcentrating, solid-phase extraction is a well suited technique, especially when the analytes are contained in complex environments. For a successful enrichment of the rhodamine and eosine with a simultaneous separation from the sample matrix, choosing the right sorbent material is a very important step. The PMM is organic polymer, theoretically the protonated and the deprotonated molecules can be used for extraction. Nevertheless, the high content of inorganic ions in aqueous reservoir samples will overload any sorbent. However, the solid-phase extraction material will resist the high organic load solved in aqueous samples and still enrich the different adsorbates.

The signal-to-noise ratio is the most frequent parameter used to report the diapason concentration (RDC) and the limit of detection (LOD). In this study, the LOD was defined as the real concentration required to produce a signal-to-noise ratio of three. The medial for the rhodamine was found to be approximately $0,06$ mg/L and $1,2$ mg/L in case of eosine. The LOD discounts the solid-phase extraction step. Including the enrichment, the detection limits lower down by factor 380. To proof the capability of the SPE, the extraction efficiency (EE) was determined. Since the SPE is followed by esterification the extraction efficiency instead of the recovery rate is obtained.

The ratio between sample volume before and after solid-phase extraction equals to the enrichment factor. The concentration of the rhodamin or eosin before SPE is known. The concentration after SPE is the product of the concentration prior to SPE multiplied with the enrichment factor.

Conclusions

Adsorption of rhodamine into PMM was studied in batch mode. The effects of various operating conditions, namely, pH, initial dye concentration and temperature were investigated for the batch operation. The equilibrium process was investigated as well. The adsorption of rhodamine occurred in the pH range from 3 to 12, achieving maximum values at pH 5–12. The complete sorption on 0.6 mg of the PMM was attained for 150–170 mL of the solution. For lower initial concentration of the dye, the adsorption is very fast. After 210 min of operation, the dye adsorption was 99,2 % for an initial dye concentration of 0.5 mg/L but 46 % for 50 mg/L.

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ТВЕРДОФАЗНАЯ ЭКСТРАКЦИЯ И ХРОМАТОГРАФИЧЕСКОЕ ОПРЕДЕЛЕНИЕ ФТОРБЕНЗОЙНЫХ КИСЛОТ В НЕФТЯНЫХ МЕСТОРОЖДЕНИЯХ

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SOLID PHASE EXTRACTION AND CHROMATORGAPHIC DETERMINATION OF FLOUROBENZENE ACIDS IN OIL-WATER RESERVOIR

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