The Effect of the Electrostatic Field on The acid-base properties Of Indigo Carmine Indicator through Immobilization

Haider Shanshool Mohammed and Ali Nadhim Sabbar

Abstract— The possibility of immobilizing the Indigo carmine indicator on the surface of quartz fibers to create a flow-through sensor was studied. The values of the pKa of the transition for free and immobilized indicator, and the effect of the ionic strength of the solution are determined. The results can be used for the development of flow-through sensors reversibly changing color depending on the pH of the solution.

Index Terms — Electrostatic filed, indigo carmine, sensor, ionic strength, pKa, immobilization.

1. INTRODUCTION

THE search for new materials and media to immobilize analytical reagents and modify their properties remains actual task of the test analysis.

To detect and determine substances in chemical test methods use various reactions (acid-base, redox, complexes synthesis) with the participation of the reactants, usually known by the color reactions in solutions [1]. Immobilization of reagents on a solid matrix (cellulose, ion exchanger, polymer, silica xerogel et al.) or the transition to the organized solutions surface active agents is accompanied by a change in the properties of the reactants. Variation properties of analytical reagents under the influence of the medium or carrier allow you to create new methods with improved metrological and operational characteristics. The most studied environmental effects for reagents that are photolytic indicators [2, 3].

In the present work we have done immobilization of acid-base indicator indigo carmine on the surface of the quartz fiber by pre-adsorption on the same surface of the cationic polymer Poly (diallyl dimethyl ammonium chloride) (PDDA). The polymers have a molecular weight of about 100 kilo Daltons, strongly adsorbed on the quartz surface. Thus modified quartz surface can subsequently adsorb anionic dyes, including some acid-base indicators. However, immobilized thus indicators have characteristic transition pK values that differ from the usual volumetric properties. In this paper, we conducted a quantitative measurement of pKa indigo carmine and its dependence on the ionic strength of the solution for three cases (when the indigo carmine is in aqueous solution, When the indigo carmine is in aqueous solution in the presence of dissolved PDDA, and indigo carmine when immobilized on the surface of the quartz fiber whose surface is modified by pre-adsorption PDDA).

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2. EXPERIMENTAL PART

The pH was measured with a pH meter Expert Automatic pH titration was performed on the

complex body-weight Dosing "Titration". Optical density measurements were performed device Expert-003 Dialogue at a wavelength of 525 nm (three device manufacturing Ekoniks- Expert, Russia). Weighting was performed on the scales CAS-MWP-300 (Vibra) with an accuracy of 0.1mg. PDDA samples were kindly provided by Professor BI Shapiro. Use indicators indigo carmine marks «чда» sodium chloride and NaOH marks «х.ч». In we used by distilled water. Quartz felt marks «Холст ХКВ-0.05» purchased the firm "Silica" (Russian Federation). The solutions were prepared volumetric weight method. PDDA 0.1% polymer solution was prepared.

This solution was used as a medium for titration. The starting solution had a concentration of indigo carmine 1, 00 g /L. Working solutions were prepared by diluting the stock solution so that the absorbance at the maximum value was about 0.5. The volume-weight method two series of four NaCl solution was prepared at a concentration of 0.001 M, 0.01 M, 0.1 M, 1M, containing only the first series of indigo carmine, and the second series indigo carmine and 0.1% PDDA. The prepared sample solution was titrated with NaOH (5M) using an automatic titrator "Titration". With a special program that provides measurement of the optical density of the pH value Immobilization indigo carmine on the surface of the quartz felt conducted by using polymer PDDA follows. In one beaker put one piece of quartz fiber and added prepared 1% solution of the polymer. After that waited 24 hours and washed one piece 10 times with tap water and 2 times with distilled water. Then in a beaker was added indigo carmine indicator (stock solution) to the one piece and left it for 24 hour and washed 10 times with tap water and 2 times with distilled water. Quartz felts was the saturated by characteristic pink color, and the aqueous solution for quartz felts remained colorless. After that, we produced a manual titration indigo carmine was immobilized on silica wool modified by PDDA polymer with NaOH solution (5 M).

3. MEASURMENT TECHNIQUES

- The measurement of titration curves for aqueous solution of indigo carmine has been determined.
- The measurement of titration curves for aqueous solution of indigo carmine has been determined with different concentrations of NaCl.
- The measurement of titration curves for aqueous solution of indigo carmine has been determined with polymer 0.1% PDDA.
- The measurement of titration curves for aqueous solution of indigo carmine has been determined with different concentrations of NaCl, with 0.1% polymer.
- The measurement of titration curves for aqueous solution of indigo carmine has been determined with quartz by using polymer PDDA with water and different concentrations of NaCl at 293 K.

4. RESULTS AND DISCUSSION

Typical titration curves in the coordinates of the optical density with the volume of titrant and coordinates pH-titrant with volume of titrant shown to obtain the dependence of absorbance and the pH value by created a special program for complex "Titration" delays the receipt of titrant to equal intervals of time through a predetermined time equal to 20 seconds was selected it. Measuring pKa values of transition results are shown in Figure 1. Measured thus the dependence absorbance and the pH value is shown in Figure 2. The pKa value determined in mid wavelength pH change in the optical density

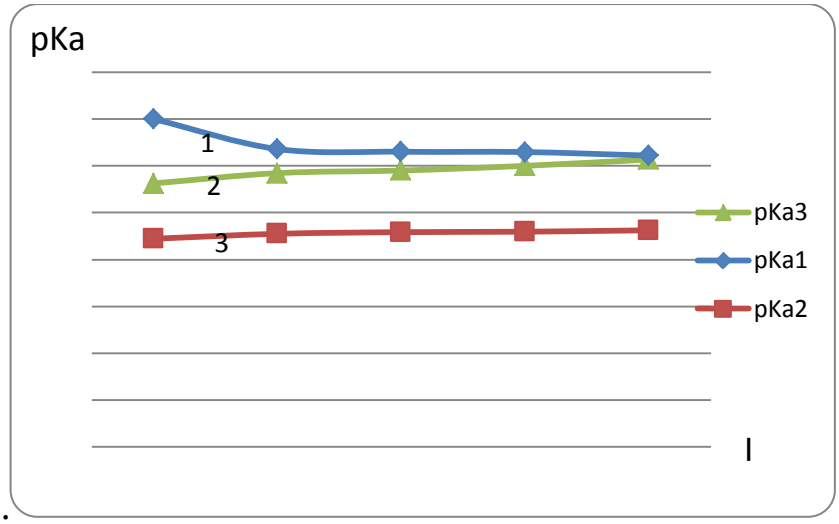

Fig.1. The relation between pKa of indigo carmine and ionic strength of the solution.

1. Indigo carmine in aqueous solution.
2. Indigo carmine in the presence of 0.1% PDDA in water solution.

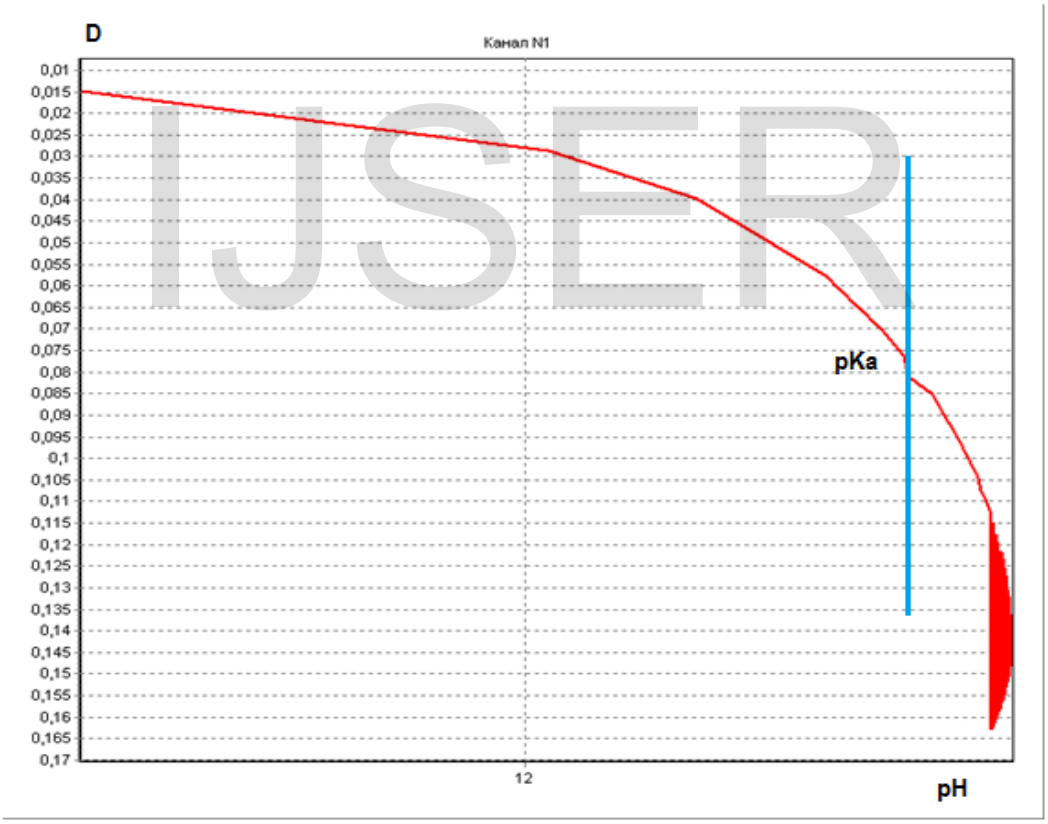

Fig.2. The relation between pH and absorbance of indigo carmine.

In the fig.1 curve(1) goes down because in the absence of the polymer the indigo carmine indicator has molecular charge (-2) and in increasing the ionic strength of the solution led to substitution of charge so increasing ionic strength led to attraction H3O+ to a molecule indigo carmine and change the equilibrium dissociation constant increases. Curve (2) and (3) correspond to changes with an increase in the dissociation constant and ionic strength however, the two curves are much lower than the curve (1) on the scale pKa. this shows is that by reacting with the polymer cation PDDA this led to indigo carmine

molecule becomes effective positive charge relative to the solution so that the cation H3O + is repelled by the indigo carmine complex with PDDA. With this is different in the equilibrium dissociation constant increase in the transition from pure water to the polymer solution and the adsorption of indigo carmine on quartz by the PDDA modified. pKa values increased with ionic strength shows that it is an effective charge of the complex is positive and different from zero so that the compensation H3O+ repulsion from the complex decreases the value of pKa , but When immobilizing the indicator the pH changes to transition increases.

5. CONCLUSIONS

1. When immobilized of indigo carmine indicator the pH changes to the acidic medium.

2. The value of ΔpH transition connected with the effect of micro phase the electrostatic potential.

3. Effect of ionic strength increasing with value of ΔpH of indigo carmine indicator after immobilization and decreasing with value of ΔpH of indigo carmine indicator before immobilization with quartz modified by polymer PDDA.

6. REFRENSES

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