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EFFECTS OF SURFACTANT STRUCTURE ON CONDUCTIVITY OF Pb(II) COMPLEX WITH 18-CROWN-6 ETHER

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ABSTRACT

In this paper effects of surfactant structure (Triton X-100 and Triton X-45) on the conductivity of Pb(II) complex with 18-crown-6 ether in polar and non-polar medium has been investigated.
Conductometric titrations with crown ethers have proved to be very useful in determining the stability constants, selectivity,
and also the thermodynamic parameters of the crown ether complexes with various cations in nonaqueous and aqueous media.
The results showed that nonionic surfactants with oxygen atoms in the hydrophilic segment of their molecules showed electron-donor properties during interactions with metal ions.
Investigation of the influence of different surfactant structure confirms, that the length of the polyether chain affects the metal-surfactant interactions.
Triton X-100 with a higher number of oxygen atoms in the surfactant structure (longer oxyethylene chain), compared to Triton X-45, affected the higher absolute values of the conductivity of systems,
but not the change in the stoichiometric ratio between a metal ion and macrocyclic ligand.

INTRODUCTION

According to our previous research of complexation metal cations with different ligands, and investigate the possibility of removing metal cations trough membrane systems, in this paper we have focused on investigation the effects of nonionic surfactants on the conductivity of formed Pb(II) complex with 18-crown-6 ether in polar and non-polar medium.

The main questions of our research were:

- Does the presence of a surfactants affect the complexation reactions of cyclic polyethers with metal cations?
- Does the surfactant structure affect on conductivity of Pb(II) complex with 18 crown-6-ether?

- ***Surfactants*** have been found, to influence the complexation reactions of cyclic polyethers with metal cations
- Surfactant molecules can interact with metal ions as the solubilization agents in the form of micellar aggregates.
- The main reason for this being either the complexation of surfactant counter ions with the crown ethers themselves or the localization of the ligand or complex or both in the surfactant micelles

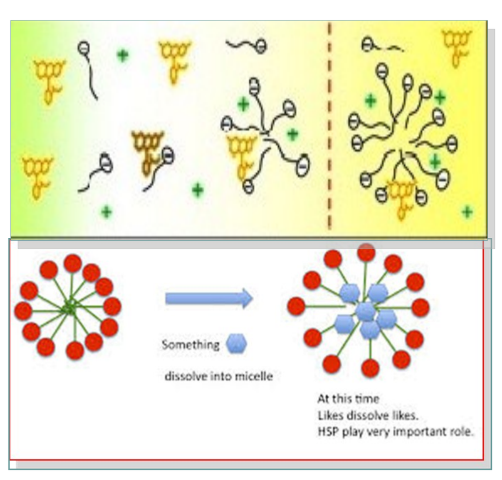

***Figure 1**. Micelle formation and solubilization process*

***Slika 1.** Nastajanje micela i proces solubilizacije*

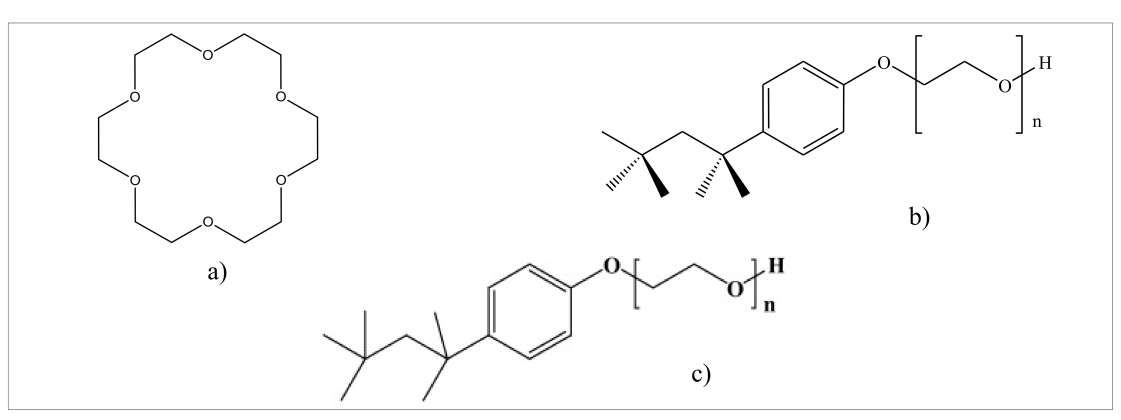

Figure 2. Structures of polyether ligands: macrocyclic "crown ether"(a) and surfactant molecules (b,c)

Slika 2. Strukture polieterskih liganada: makrociklični "kruna eter"(a) i neionskih surfaktantata (b, c)

Characteristics of surfactants: the structure of their molecules, as well as values of hydrophilic-lipophilic balance (HLB) and critical micellar concentration (CMC), are important for cation-surfactant interactions

Nonionic surfactants	Molecular formula	Molar Weight	Hydrophilic-lipophilic balance HLB	Criticall micellar concentration CMC (mM)
Triton X-100	$C_{14}H_{22}O(C_2H_4O)_{9,5}$	628	13.5	0.24
Triton X-45	$C_{14}H_{22}O(C_2H_4O)_{4,5}$	404	10.4	0.30

***Table 1**. The characteristics of non-ionic surfactants used for this paper*

***Tabela 1.** Karakteristike neionskih tenzida koji su korišteni u ovom radu*

Materials and methods

Conductometry is an electroanalytical method that measures the electrical conductivity, as a consequence of the existence of free mobile charge carriers (ions) in solution. Ions move freely in solutions under the influence of an electric field and contribute to the overall conductivity of the solution, depending on their concentration and mobility.

Reagents:

- The macrocyclic ligand: 18-crown-6, 18C6, (99%, ACROS ORGANICS)
- The nonionic surfactants: Triton X-100; Triton X-45 (p.a. Sigma-Aldrich)
- Solvent: water, dichloromethane

- All measurements were carried out at 25º C with a GLP31 Crison Instruments digital conductometer, which was calibrated regularly with the Mettler Toledo standard solutions.
- All molar conductivities were calculated after correcting for the solvent conductivity.

Procedure:

- The GLP31 Crison Instruments digital conductometer, presented in Figure 2. was used for the measurements.
- Measurements were performed at room temperature
- The change in the electrical conductivity of the solution depending on the change in the ligand concentration was monitored.

***Figure 3.** GLP31 Crison Instruments digital conductometer*

***Slika 3.** GLP31 Crison Instruments digitalni konduktometar*

RESULTS AND DISCUSION

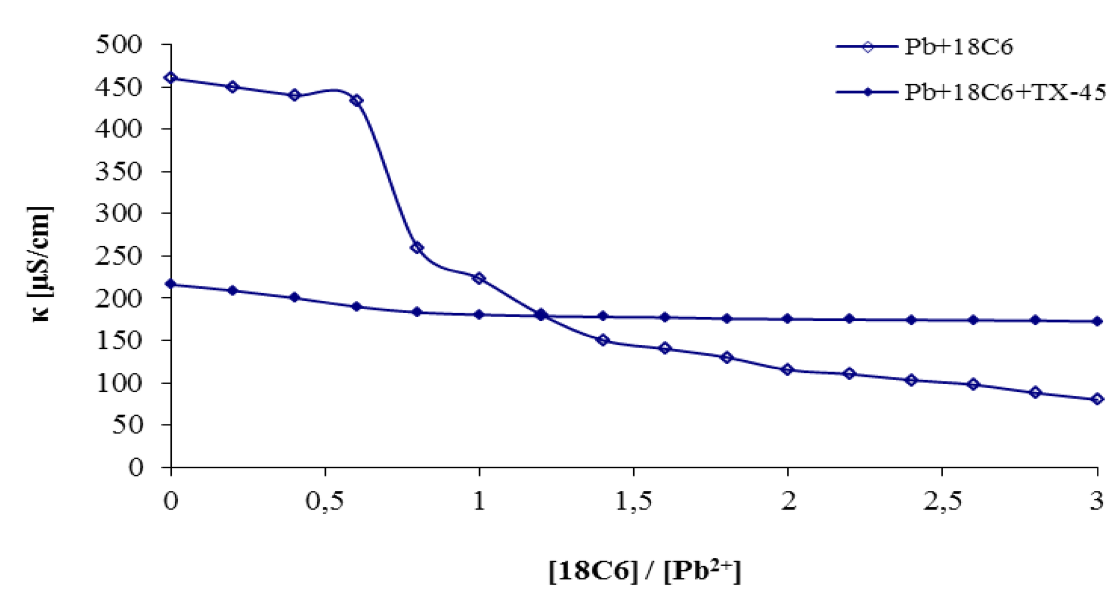

***Figure 4.** Influence of the surfactant TX-45 on a conductivity of 2-component system Pb(II) + 18C6 in aqueous solution*

***Slika 4.** Uticaj strukture TX-45 na provodljivost 2-komponentnog sistema Pb(II) + 18C6 u vodenom rastvoru*

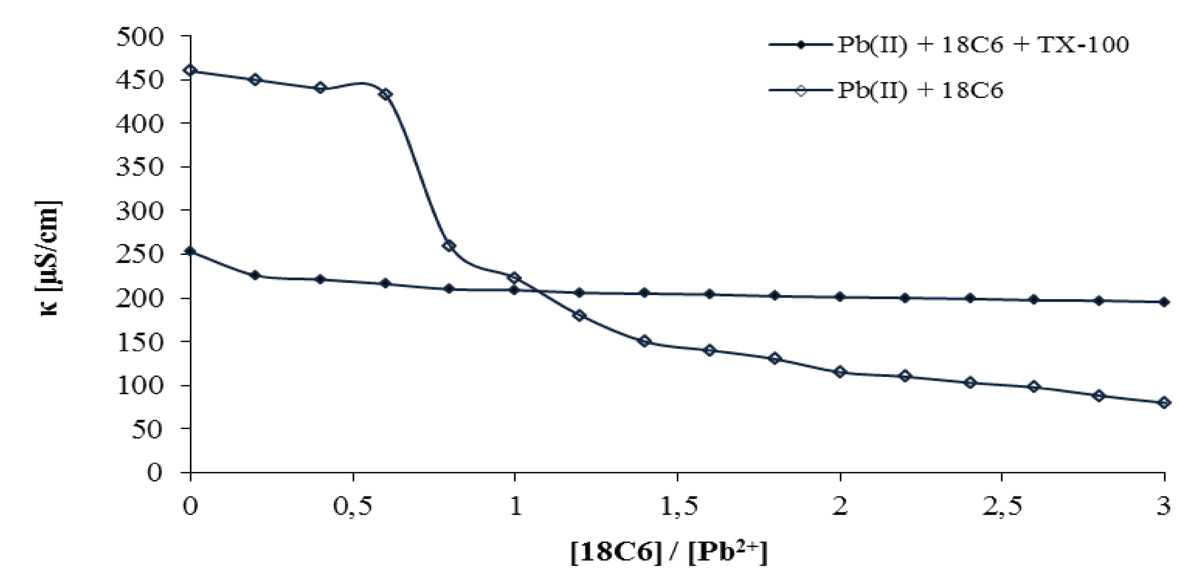

***Figure 5.** Influence of the surfactant TX-100 on a conductivity of 2-component system Pb(II) + 18C6 in aqueous solution*

***Slika 5.** Uticaj strukture TX-100 na provodljivost 2-komponentnog sistema Pb(II) + 18C6 u vodenom rastvoru*

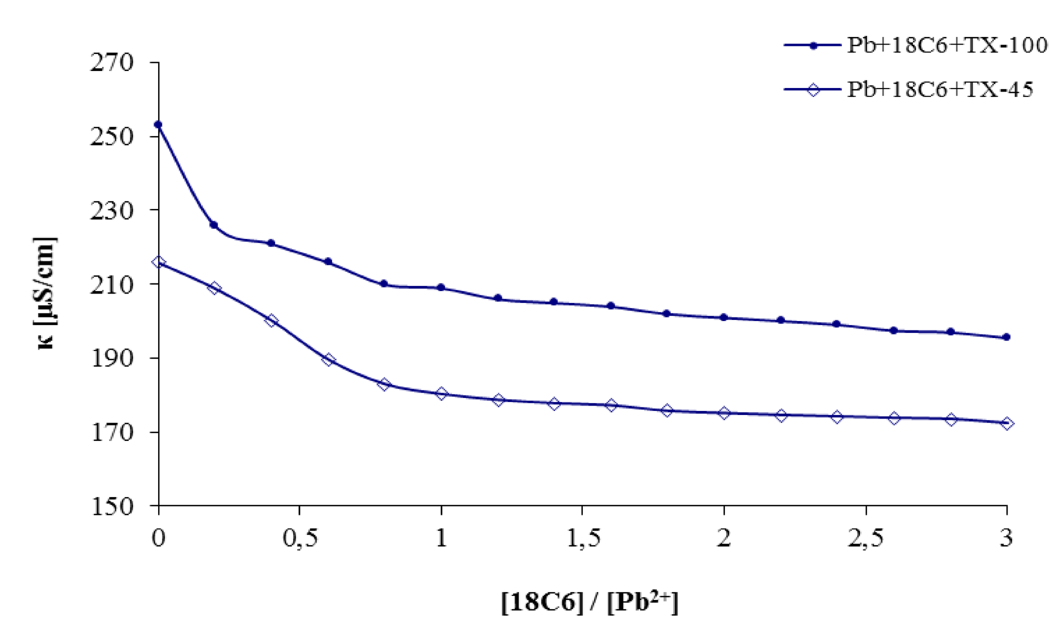

***Figure 6.** Influence of surfactant chain length on system conductivity: Pb (II) + 18C6 + TX-100 and Pb (II) + 18C6 + TX-45 in water*

***Slika 6.** Uticaj dužine lanca surfaktanta na provodljivost sistema: Pb (II) + 18C6 + TX-100 i Pb (II) + 18C6 + TX-45 u vodi*

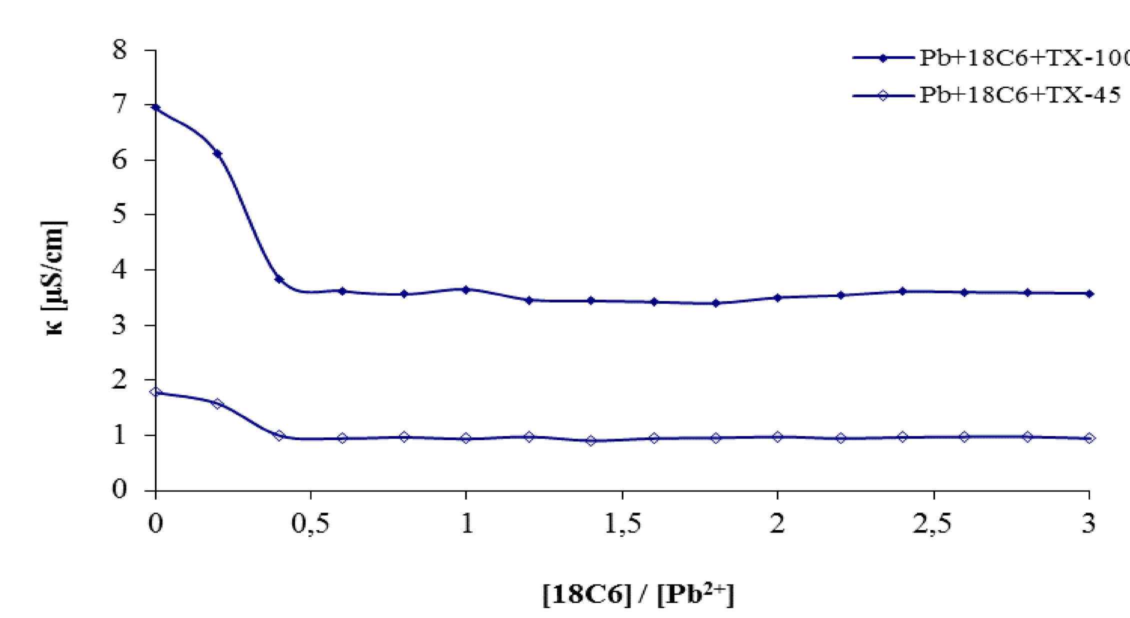

***Figure 7.** Influence of surfactant chain length on system conductivity: Pb (II) + 18C6 + TX-100 and Pb (II) + 18C6 + TX-45 in DCM*

***Slika 7.** Uticaj dužine lanca surfaktanta na provodljivost sistema: Pb (II) + 18C6 + TX-100 i Pb (II) + 18C6 + TX-45 u DCM*

CONCLUSIONS

- The influence of the surfactant structure confirms, that the length of the polyether chain affects the metal-surfactant interactions
- The addition of the nonionic surfactant Triton X-100 and Triton X-45 to an aqueous solution results in the decrease in the absolute value of the conductivity, probably due to the formation of normal micellar structures that enable solubilization of nonpolar compounds in polar medium
- The higher number of oxyethylene units in the TX-100 nonionic surfactant chain compared to TX-45 also affected the higher absolute values of the conductivity of systems of different complexity and composition, but not the change in the stoichiometric ratio between the metal ion and macrocyclic ligand
- Different intensities of conductivity contribute to the earlier assumption of different possibilities of interactions between TX-100 and Pb(II) compared to TX-45, in both solvents
- A larger number of oxyethylene units (the number of oxygen atoms as electron-donors) means the higher intensity of absorption for TX-100 compared to TX-45, and probably stronger interactions between metal and macrocyclic ligand

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