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# New environmental friendly dicephalic amine dichlorides: Nonequivalent adsorption and interactions with model polyelectrolyte

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ABSTRACT

The physicochemical behavior of new dicephalic surfactants, derivatives of tertiary amines, *N,N*-bis[3,3′-(dimethylamine)propyl]alkylamide dichlorides Cn(DAPACl)$_2$, was analyzed in terms of the advanced model of multicharge cationic surfactant adsorption, taking into account counterion specificity and the formation of surfactant ion-counterion associates. Interactions of the studied compounds in mixtures with model anionic polyelectrolyte, sodium poly(styrene sulfonate) (PSS) were also examined. Surface tension data indicate binding of surfactant to polyions occurring above a concentration threshold lying much below the critical micelle concentration (cmc) of the pure surfactant in an aqueous solution. Above this threshold very surface active surfactant/polyion complexes are formed and that leads to an abrupt drop of surface tension. The obtained results are compared with those previously reported for *N,N*-bis[3,3′-(trimethylammonio)propyl]alkylamide dibromides $C_{12}$(TAPABr)$_2$ and *N,N*-bis[3,3′-(trimethylammonio)propyl]alkylamide dimethylsulfates $C_{12}$(TAPAMS)$_2$.



## 1. Introduction

The pathway to surface-active products with specific physicochemical features useful for practical applications leads through the modification of surfactant structure and the determination of structure–property relationships [1,2]. During the past years the interest in creating novel multifunctional surface-active compounds as well as in investigation of the influence of their structure upon the performance has been increasing in chemistry, chemical technology and biotechnology. The most popular trend here is the pursuit to obtain environmental friendly compounds with desired physicochemical properties and application potential [3,4].

Various new types of surfactant architectures have been described in recent literature. These include multihead-single tail structures [5], bolaform surfactants [6], double tail-single head structures [7], multimeric surfactants (dimeric, trimeric and tetrameric) [8–12], etc. Many amphiphilic compounds naturally occurring in nature and containing more than one hydrophilic moiety possess important biological functions [13], while their synthetic counterparts proved to be useful in medical and pharmaceutical applications [14,15]. Recently much attention has been directed toward the solubilization potential of such compounds and application in template-derived drug delivery systems as well as in new drug components, antimicrobial agents, transfection enhancing agents, effective capping agents for the stabilization of Ag nanoparticles, structure-directing agents for the synthesis of mesoporous materials, models for biomembranes or reaction media (ionic liquids), in fabrication of biosensors and biomolecular devices such as disinfectants and antiseptics for food and body surfaces [16–22].

We have recently examined the structure–performance relationships of various cationic surfactants and their utility in nanoparticles fabrication [17,23]. As a continuation of our study we present here findings on a newly synthesized environmental friendly homologous series of dicephalic *N,N*-bis[3,3′-(dimethylamine)propyl]alkylamide dichlorides Cn(DAPACl)$_2$, which are of particular interest, as they contain a labile amide group in the molecule and their facile synthesis is promising for practical technological applications (Scheme 1).

Both the intermediates and final products were obtained with high yields via a simple two-step reaction, mild conditions of pressure and temperature being used. The materials may thus be available at industrial scale, employing reactions with practically no waste or by-products formed.

Because of broad potential applications in nano- and biosciences, issues of the synthesis of new surface-active compounds as well as the co-adsorption of surfactants and polymers are gaining increasing attention in the literature [24–26]. From the

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