

# THE INFLUENCE OF CATIONIC SURFACTANT DESORPTION TO COTTON ANTIMICROBIAL PROPERTIES

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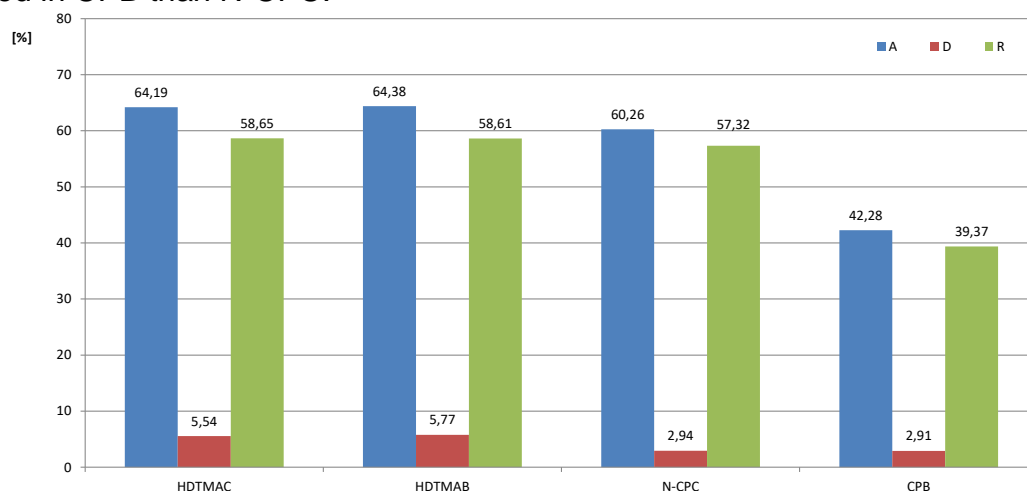
At the beginning of 20<sup>th</sup> century, cationic surfactants were used as leveling agents and as finishing agents in commercial laundries, while nowadays are gaining more importance due to its functionality and environmental benefits. Quaternary ammonium compounds (QACs), especially the ones having chains of 12–18 carbon atoms, are widely used as antiseptics and disinfectants, as well as softeners. QACs can be used for clinical purposes as well as for hard-surface cleaning and deodorization. QACs have ability to inactivate the bacterial cells, whilst the quaternary ammonium group remains intact and retains its antimicrobial ability as long as the compound is attached to textiles [1-3]. However, in the case of cationic surfactants, there is a problem with desorption since the cationic surfactants are attracted to the negative charged surface of cotton fibers by electrostatic interactions as well as possible reaction with anionic surfactant during laundry [1-5]. Therefore, in this paper the adsorption and desorption of four different cationic surfactants on standard cotton fabric was researched, as well its influence to fabric antimicrobial properties.

For this investigation standard cotton fabric of 170 g/m<sup>2</sup> (WFK) and four different QACs: Hexadecyltrimethyl ammonium chloride (HDTMAC), Hexadecyltrimethyl ammonium bromide (HDTMAB), N-cetylpyridinium chloride (N-CPC) and Cetylpyridinium bromide (CPB), have been used. The adsorption of 1 mmol/l QAC was performed at 25 °C, 30 min, BR 1:20, on Heidolph Unimax 1010 orbital shaker. The adsorbed QAC amount was determined indirectly by potentiometric titration on automatic titration unit Titrino 736 GP (Metrohm) using ion-selective electrode (High Sense surfactant electrode, 6.0504.150, Metrohm) and Ag/AgCl (Metrohm) as referent electrode. The 1 mmol/l sodium lauryl sulphate (Sigma-Aldrich) was used as titrant/polyelectrolyte of opposite charge [5]. Desorption was performed same way as adsorption, only in distilled water, from which the amount of desorbed surfactant was determined, and the residual amount was calculated.

The antimicrobial activity was determined according to AATCC TM147-2016, Antibacterial Activity Assessment of Textile Materials: Parallel Streak Method. Activity was determined to Gram-positive bacteria *Staphylococcus aureus*, Gram-negative bacteria *Escherichia coli*, and microfungi – yeast *Candida albicans*.

The adsorbed, desorbed and residual amount of QAC on 5 g of standard cotton fabric is presented in Figure 1. The cationic QAC are attracted by electrostatic interactions with the negative charged surface of cotton fibres. The adsorption of N-CPC is lower than the HDTMAC, and CPB than the HDPB, as the result of weaker cationic charge of pyridine

group. The presence of the aromatic ring in the pyridinium group reduces the adsorption. However, pyridinium group increases the stability of the already adsorbed surfactant on the fiber, and therefore the desorbed amount is lower. This steric barrier is more enhanced in CPB than N-CPC.



**Figure 1** Adsorbed (A) , desorbed (D) and residual amount of QAC standard cotton fabric

The antimicrobial activity after adsorption and after desorption is presented in table 1. From the results of antimicrobial activity it is evident that all QACs show great activity toward Gram-positive bacteria *Staphylococcus aureus* and microfungi *Candida albicans* even after desorption. Activity on Gram-negative bacteria *Escherichia coli* shows difference between QACs. Ammonium QACs with ammonium group, HDTMAC and HDTMAB, show lower activity after adsorption, whilst pyridinium ones, show excellent activity. After desorption, there is no antimicrobial activity to Gram-negative bacteria.

**Table 1** The antimicrobial activity after adsorption (A) and after desorption (D)

Microorganism	<i>Staphylococcus aureus</i>		<i>Escherichia coli</i>		<i>Candida albicans</i>	
	A	D	A	D	A	D
HDTMAC	+	+	+/-	-	+	+
HDTMAB	+	+	+/-	-	+	+
N-CPC	+	+	+	-	+	+
CPB	+	+	+	+/-	+	+

QAC adsorption is different for different hydrophilic ammonium and pyridinium groups in a surfactant molecule. Ammonium group leads to higher adsorption, whilst pyridinium have better bonding. The antimicrobial results show similar behavior – pyridinium group QACs show better antimicrobial activity.

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