

Wetting - display capacity of some new superficialactive cationic polyethers in food hygienization

C. Jianu^{1*}, Ileana Cocan¹, T.I. Trașcă¹, A. Riviș¹, Monica Negrea¹, Mihaela Cazacu¹,
G. Bujancă¹, I. Jianu¹

¹ Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Processing Technology,
300645-Timișoara, C. Aradului 119, Romania

Received: 15 September 2010; Accepted: 31 November 2010

Abstract

Colloidal features (wetting) of conditioning auxiliaries (additives) of plant protection active principles constitute, together with toxicity, a decisive technical index in forming administering receipts in modern ecological agriculture and foodstuff processing all during the agroalimentary processing and consumption chain.

In this paper we show the results of a study on a new class of superficialactive compounds N,N-dimethyl-N-alkyl (CH₃-C₁₆H₃₃)-N-β-alkylaryl (C₉H₁₉-C₆H₄-) polyethylenoxy ($\bar{n} = 3 - 20$) ethylammonium chlorides.

Structures have real colloidal and bacteriostatical abilities compared to a wide spectrum of microorganisms (tested in studies related to this paper).

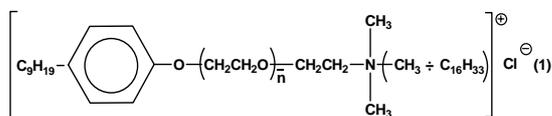
Low toxicity of polyoxyethylene chains (PEO) together with that of other structural units in provide the studied glymes with a high compatibility in relation to environment and to plant and animal organisms of the food chain.

Keywords: moistening, display, glime, polyether cationic surfactants, colloids.

1. Introduction

Literature studies report a wide range of superficialactive cationic compounds [1-6] but limited and sporadic superficialactive cationic polyethers [7-11].

Studied cationic polyethers, (1) [1-6] have been proposed, with optimum results in cleaning recipes in food processing with other nonionic – anionic components (soaps) based on bacteriostatic powers recognized of the class.



Moistening-displaying, as a surface phenomenon indicating the ampleness and efficiency with which the contact between a support and an aqueous flow takes place depends on the capacity of the superficialactive structure of reducing in dynamic conditions, the superficial tension at the interface support-flow, on the mobility of the molecule in the flow and on the absorption capacity at the interface. As the capacity of absorption also depends on the nature of the support (dielectrical constant), they make the distinction between hydrophilic surfaces (with a dielectrical constant lower than that of water, e.g. cellulose, cotton) slightly moistened by water, and hydrophobic surfaces (with a dielectrical constant higher than that of water, e.g. synthetic

fibres) heavily moistened by water or polar liquids. Together with the nature of textile support, we also distinguish in the process of adsorption other two parallel, concurrent phenomena dependent on the superficial structure and to environmental permittivity: dissorption (adsorption of the water at the interface) and adsorption proper. Dissorption is accompanied by the decrease of water concentration in the adsorption stratum and by the areal concentration of the colloidal solution, which is the more concentrated the higher the support's hydrophilia.

As both a colloidal feature and a technological operation, wetting is defined as the time (seconds) necessary of a defined concentration flow superficialactive compounds (1) expressed in (g/L) or (mol/L) of wetting (penetrating) a standard textile of known nature.

As diderived glimes, they have a guided regulation capacity of the HLB balance through the change of the medium degree of oligomerisation (\bar{n}) of the polyoxyethylene chain (PEO). Can thus obtain a wide range of structures such as mycelium solute, dispersion, emulsion, and wetting agents, etc., through the cyanoethylation of polyethoxylated alkylphenols with a medium degree of oligomerisation (\bar{n}) between 3 and 20 structural oxyethylene units (EO) in alkaline catalysis with monomer acrylonitrile, followed by a classical hydrogenation in heterogeneous catalysis of intermediary nitrile thus obtained, and finally alkyl quaternarisation of the polyetheramine obtained with methyl hexadecyl-chlorides to obtain (1).

These are biodegradable in water plants, which ensure special ecological features and high compatibility within the restrictive legal ensemble of a foodstuff processing integrated in an extremely polluted environment.

2. Materials and methods

2.1 Materials

N,N-dimethyl-N-alkyl ($\text{CH}_3\div\text{C}_{16}\text{H}_{33}$)-N- β -alkyl-aryl (C_9H_{19} - C_6H_4 -) ammonium chlorides (TPA).

2.2 Assessing moistening-displaying capacity (U)

The moistening capacity is expressed by the polyether cationic superficialactive (1) concentration in the solution (g/L-corresponding to the moistening type (seconds) defined as the interval between the moment the textile skein was

sunk in the flow and the moment it begins to fall (SR EN 1772:2002). The main values of the moistening-displaying capacity in the series of polyether cationic superficialactive (1) compounds studied are shown in Tables 1.

Allow to sink a piece of cotton cloth, suspended in solution with surface active agent (superficialactive cationic polyether). By entering the solution within the textile, the initially air on its surface is dislodged *and the* piece of cloth begins to sink to the bottom of the vessel. Measure elapsed time between the time the cloth sinking and the moment when it begins to sink.

Equipment (figure 1)

- ✓ Device for determining, composed of:
 - a) 800 mL Berzelius beaker;
 - b) stainless steel wire "rod" (interim clamping system of textile) approximately 2 mm in diameter, having a length equal to one glass. At the top, the "rod" is folded so that it can be supported on its edge. The bottom has a horizontal arm which reaches the middle glass terminated with a taper ring opening. On the horizontal arm marked distance of 30 mm the inner wall of the ring;

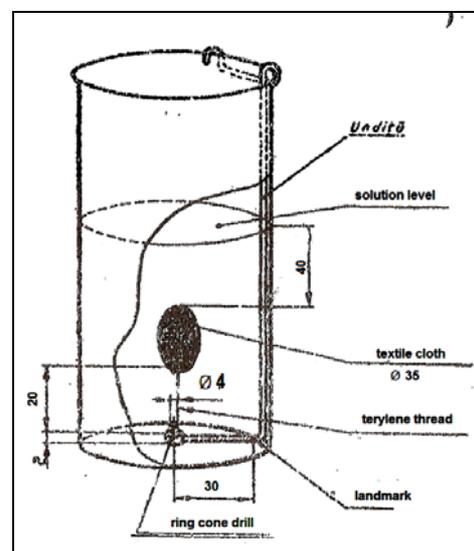


Figure 1. Installation for determining the wetting-etalation power of superficialactive cationic polyethers

- c) yarn with hook weight of 0.03 g;
- d) textile cloth or textile fiber skeins, (STAS 1213-50 and then equivalent) "Canvas lining" 35 mm diameter, obtained by punching. Previously recommended breaking material and maintaining

24 hours later in a desiccator with calcium chloride. Not allowed distorted rings.

✓ *Chronometer*

The cationic active agent examined (1) is dissolved in distilled water in double concentration toward the concentration in the quality standard prescribed. For complete dissolution, if necessary it can be boiling hot.

Corrects to a prescribed working concentration, by dilution with double water hardness to work prescribed hardness.

Working mode

The determination is performed at temperature indicated in the quality standard assimilated of investigational product. If it does not prescribe a defined value, the determination is performed at 25 ± 2 ° C. For different temperatures from the environment is access a thermostat.

Specified concentrations are chosen so watering time not to be under **3 seconds** or greater than **300 seconds**.

Determination is generally performed in water with 10 german degrees hardness. For special tests, is using higher water hardness or distilled water if necessary, if it is recommended in quality standard assimilated of investigational product.

It is introduced in a glass about **500 ml** of tensioactive solution, so that from the solution level to the upper edge of the cloth is **40 mm** (Figure 1).

Textile cloth is ranks near the edge of the textile wire and is secured to the drill lines ring so that the free length of wire to be 30 mm, according to the marking lines on the horizontal arm.

During surgery will avoid touching oiled objects. Rod is inserted in superficialactive solution supporting it on the edge of the cup and is measure the time since the introduction of canvas dial in solution by the time it begins to sink to the bottom glass.

For each studied concentration is performed so many determinations until its get ten values which does not show relative errors above **20%**. Watering time for respective concentration is given by the arithmetic mean of ten determinations.

On a logarithmic chart are register watering times which corresponds to worked concentration values hovering around on straight. Is graphic interpolating the concentration value of surface agent of watering time (**100 seconds**). This value, expressed in g / L, is the irrigation power. The relative error is calculated as follows:

$$\varepsilon = \frac{f}{A} \cdot 100$$

where:

ε - relative error;

f - difference between result of determination and arithmetic average of the results;

A - determination result (average watering time, in seconds).

In the analysis of superficialactive cationic polyether will nominate the temperature and hardness of fleet (solution) which is being.

3. Results and Discussion

Long chain cationic surfactants containing polyether linkage (1) were synthesized and

also their antibacterial activities in terms of growth inhibition of *Staphylococcus aureus* and *Escherichia coli* were preliminary examined.

Some of them also preliminary tested against *Trichophyton asteroides*, *T. interdigitale*, *T. granulosus*, *Epidermophyton floccosum* and *Microsporum canis*. The octyl radical (R_1) was more potent than the decyl radical (R_1). Also no definite correlation between positional isomers and chain length and antibacterial activities was observed.

Analysing the moistening-displaying effect in these superficialactive (table 1) structures shows a parallel between structure and effect, similar to those mentioned in our previous discussion. A few structural aspects specific to the class and that probably also reflect in the global effect need to be mentioned here: the removal of the hydrophilic polar group towards the centre of hydrocarbonate chain together with the length of the hydrocarbonate chain R , by the unfavourable entropic factor, results in a diminution of the moistening-displaying effect in parallel with the capacity of reduction in dynamic conditions of the tension at the separation interface textile support - flow.

Table 1. Moistening – displaying effect of N,N-dimethyl-N-alkyl (R₁) (CH₃÷C₁₆H₃₃)-N-β-alkylaryl (R) (C₉H₁₉-C₆H₄-) polyethyleneoxy (\bar{n} = 3 – 20) ethylammonium chlorides

No.	n	R ₁	Flow concentration (g/L)	Moistening time (sec.)			Textile fibre	
				Notreated	Treated			
					20°C	40°C		60°C
1.	3	1	2	146	2.5	2.1	1.5	PES
2.	9	4	5 ^x	146	3.0	2.5	1.2	
3.	12	8	2	146	2.7	1.4	1.2	
4.	20	16	0.5 ^x	146	4.0	2.8	1.7	
5.	3	4	0.5 ^x	180	1.4	1.2	1	PES-AC
6.	6	2	2	180	2.2	1.8	1.1	
7.	12	2	5	180	1.8	1.1	1	
8.	6	2	2	180	2.3	1.7	1	
9.	12	16	5 ^x	40	1.6	1.4	1.2	C
10.	9	4	5	40	1.5	1.3	1.2	
11.	12	2	0.5 ^x	40	1.5	1.2	1.1	
12.	12	8	1	40	1.7	1.5	1.2	
13.	3	1	0.5 ^x	70	1.5	1.0	1	C-PES
14.	12	4	2	70	1.2	1	1	
15.	20	2	5 ^x	70	1.0	1	1	
16.	9	2	0.5	70	1.5	1.1	1	
17.	3	8	0.5	4000	1.6	1.3	1.1	C-FR
18.	9	2	5 ^x	4000	1.2	1.0	1	
19.	6	4	2 ^x	4000	1.7	1.5	1.3	
20.	9	1	0.5	4000	1.5	1.4	1.2	
21.	3	1	2	110	1.9	1.6	1.2	PNA
22.	9	8	5 ^x	110	1.7	1.5	1.0	
23.	9	4	2	110	1.9	1.7	1.3	
24.	12	2	5 ^x	110	1.8	1.6	1.4	

^x) Flow hardness (2°G); PES – polyester; PES-AC – polyesteracetate; C – cotton; C-PES – cotton – polyester; C-FR – cotton frofir; PNA – polyacrylonitrile.

On the whole, nevertheless, quaternary salts are better moistening-displaying agents than analysed nonionic - anionic structures due to the affinity of the cation polar group towards anionic supports, no matter their degree of hydrophobia (cellulose, cotton, natural or synthetic fibres) that fix the cation structure at the interface textile support - flow and facilitate the diminution of superficial tension.

Evolution of the relative hydrophilic / hydrophobic balance (*HLB*) in the series N,N-dimethyl-N-alkyl (R₁) (CH₃÷C₁₆H₃₃)-N-β-alkylaryl polyethyleneoxy (\bar{n} = 3 – 20) ethylammonium chlorides and its knowledge is decisive in directed choosing the optimal superficialactive structure of cleaning operation in food processing imposed by case law.

Besides this the conformation structure has a major role to ensure awareness and how to "wrapping" on separation interface of the metallic, ceramic, plastic, textile, food support/ Watering fleet – that display (wetting case) the metallic, ceramic, plastic, textile, food support/air (foaming case).

4. Conclusion

Experimental results reported confirm the colloid moistening-displaying competences, of N,N – dimethyl – N – alkyl (R₁) - (CH₃ ÷ C₁₆H₃₃)-N-β-alkylaryl (C₉H₁₉-C₆H₄-) poly-ethyleneoxy (\bar{n} = 3 – 20) ethylammonium chlorides under study and recommend them as potential additivition structures and in efficient hygiene receptures in agroalimentary processing (metal, textile, plastic, etc. surfaces).

Acknowledgement.

This article was supported by Research Grant UEFISCSU (Executive Unit for Financing Higher Education and University Scientific Research), PD 63/2010.

References (selective list)

1. I. Jianu, Brevet R.S.R. 77367, (1981);
2. I. Jianu, Brevet R.S.R. 78634, (1981);
3. I. Jianu, Brevet R.S.R. 82433, (1983);
4. I. Jianu, Brevet R.S.R. 81854, (1983);
5. I. Jianu, Brevet R.S.R. 81853, (1983);
6. C. Jianu, Cercetări privind potențialul aditivi de complexare cu ioni metalici pentru îmbunătățirea valorii alimentare a unor materii prime horticoale, *Teză de doctorat*, 2006
7. U.S. Patent, 5094770 (1992);
8. U.S. Patent, 5318727 (1994);
9. Kjell Magne Askvik, Stig Are Gundersen, Johan Sjöblom, Juha Merta, Per Stenius, Complexation between lignosulfonates and cationic surfactants and its influence on emulsion and foam stability, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 1999, 159(1), 89-101, [doi:10.1016/S0927-7757\(99\)00165-X](https://doi.org/10.1016/S0927-7757(99)00165-X)
10. Tae-Seong Kim, Toshiyuki Kida, Yohji Nakatsuji, Toshikazu Hirao, and Isao Ikeda, Surface-Active Properties of Novel Cationic Surfactants with Two Alkyl Chains and Two Ammonio Groups, *Journal of the American Oil Chemists' Society*, 1996, 73(7), 907-911, [doi: 10.1007/BF02517994](https://doi.org/10.1007/BF02517994)
11. E. D. Goddard, R. B. Hannan, Cationic polymer/anionic surfactant interactions, *Journal of Colloid and Interface Science*, 1976, 55(1), 73-79