SELECTION ON NONIONIC SURFACTANTS IN THE DECONTAMINATION SOLUTION

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Abstract: Limited opportunities for adequate and timely protection of the population and the infrastructure required to increase the efficiency liquidation of consequences of chemical, radiological and biological agents. This report stems from the increased requirements to the characteristics of solutions for decontamination in terms of completeness of processing and environment protection. Surfactants are important component in decontamination solutions to improve the wetting power. It is appropriate to search for alternatives other than compositions containing surfactants. The surface activity of outdated solutions for special handling needs to be studied since they are directly related to the performance properties.

The absence of qualitative and quantitative characteristics of the performance properties of surfactants and detergent formulations for decontamination that could be used instead of basal detergent is a scientific problem addressed in this report. Surface activity is a qualitative criterion of veterinary and wetting ability of solutions for decontamination which is directly related to temperature variables.

The report includes research on surface activity of various formulations containing surfactants in order to achieve good wetting action of the solutions for special processing. Following the survey by graphical differentiation of the concentration depends on the surface tension. We use the supplied software product obtained values for surface activity of solutions for decontamination, which are the basis for qualitative and quantitative evaluation of the wetting power. When choosing a surfactant a variety of other factors must be considered. Studies conclude that specific surfactants need to be chosen for each specific site. According to the results of a comparative study of surfactants that can be used to solubilize PCE, some of them proved to be more efficient than others. Surfactants are typically used in conjunction with other surfactants and other products for CBRN decontamination. Surfactants can be used to aid in the removal of a wide range of contaminants.

ПОДБОР НА НЕЙОНОГЕННИ ПОВЪРХНОСТНО АКТИВНИ ВЕЩЕСТВА В РАЗТВОРИ ЗА ДЕКОНТАМИНАЦИЯ

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Резюме: Ограничените възможности за адекватна и своевременна защита на населението и инфраструктурата налагат да се повиши ефективността по ликвидирането на последствията от химически, радиационни и биологични събития. Актуалността на доклада произтича от повишените изисквания към характеристиките на разтворите за специална обработка по отношение на пълнотата на обработката и при опазването на околната среда. Повърхностно-активните вещества са важен компонент на дезактивиращите, дегазиращите и дезинфекциращите разтвори за повишаване на омокрящата им способност. Целесъобразно е търсенето на алтернативи за използването и на други композиции съдържащи повърхностно-активни вещества. Изследванията на повърхностната активност на разтворите за специална обработка са актуални поради факта, че са пряко свързани с експлоатационните им свойства.

Липсата на качествени и количествени характеристики за експлоатационните свойства на повърхностно-активни вещества и детергенти в състави за специална обработка, които биха могли да се използват вместо базов синтетичен продукт е научен проблем поставен за решаване чрез доклада. Повърхностната активност е качествен и количствен критерий за омокрящата способност на разтворите за специална обработка и е температурно зависима величина.

Доклада включва изследвания върху повърхностната активност на различни състави, съдържащи повърхностно-активни вещества с оглед постигане на добро омокрящо действие на разтворите за специална обработка. Вследствие от проведеното изследване чрез графично диференциране на концентрационната зависимост на повърхностното напрежение с помощта на приложен софтуерен продукт са получени числени стойности за повърхностната активност на разтвори за специална

обработка, които са основа за качествена и количествена оценка за омокрящата им способност. При избора на повърхностно активно вещество трябва да се отчитат различни фактори. От проучванията които са направени може да се заключи, че повърхностно активни вещества трябва да бъдат избрани за всеки конкретен обект, който ще се обработва. За да се намалят възможните селекции, при сравнение на повърхностно активни вещества, които могат да се използват, може да се подберат няколко, които са по-ефективни от други. Повърхностно активните вещества обикновено се използват в комбинация с други повърхностно активни вещества и вещества за деконтаминация. Повърхностно активни вещества могат да се използват за подпомагане при отстраняването на широк спектър от замърсители.

1. INTRODUCTION

Limited opportunities for adequate and timely protection of the population and the infrastructure required to increase the efficiencyof liquidation of consequences of chemical, radiological and biological agents. Surfactants are important component in decontamination solutions to improve their wetting power. It is appropriate that other alternatives be found for the use of compositions containing surfactants.

2. MEASUREMENT METHODOLOGY AND RESEARCH OBJECT

The decontamination solutions, applicable to eliminate radioactive contamination, are mainly required to have enough wettability for the processed surfaces. Surface activity is quantitative and qualitative criterion of deactivation solution’s wettability and it is also a temperature dependent value. It has been defined by Gibbs’ absorption isotherm:

$$\alpha = -\frac{C}{RT}\left(\frac{\partial \sigma}{\partial C}\right)_A \qquad (1)$$

where: α is surface adsorption concentration, mol/g; C– concentration of solution, mol/l; R– universal gas constant, J/mol.K, R=8,3J/mol.K; A– surface of processed area, m^2; $g = \left(\frac{\partial \sigma}{\partial C}\right)_A$ - surface/ capillary/ activity.

The quantity $\left(\frac{\partial \sigma}{\partial C}\right)$ can have a different sign. For surfactants $\left(\frac{\partial \sigma}{\partial C}\right)_A$ it is minus, hence for surfactants α >0 the adsorption on the surface of the solution is positive.

To determine the surface activity of solutions for decontamination, we need to be familiar with the graphical and analytical type of the relation between surface tension and concentration, which is the first stage of the methodology. Analytically, the interdependence of surface tension and concentration can be formulated by regression equations using a software “Wolfram mathematic”.[1, 2]

It is appropriate to use certain methods and trials for measuring surface tension in temperature dependence. Measurements of surface tension σ versus concentration C must be conducted a number of times until we reach the point at which the increase in C does not change σ at constant temperature. Measurements of surface tension is conducted in a dynamic method. The temperature of the solution samples is regulated indirectly by using heated water as coolant thermostat [1, 4].

The amounts of studied objects’ surface activity are defined with graphic differentiation of $\sigma = f(C)$ correlation, applying computer platform [1, 4].

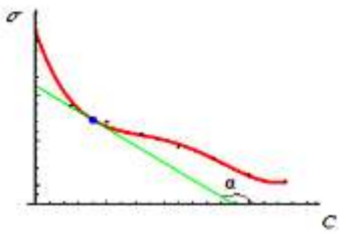


Fig. 1 Graphic chart defining surface activity of solutions.

Water solutions of surfactants are used for conducting deactivation. In the Bulgarian Army the composition DV-2 is in use, it contains alkylphenolpolyglycol ethers, sodium threepolyphosphate and sodium sulphate. The purpose of this study was to conduct comparative analysis between the wetting capability of water solutions containing DV-2 and water solutions of non-ionic surfactants which may be used for decontamination in different temperature and concentration range.

Non-ionic surfactants have a lot of benefits and the preferred ones for decontamination [6, 7]. Their adsorption to a negatively charged interphase water / air reduces load surface and film thickness, i.e., conditions for electrostatic destabilization are created [8]. This requires their use with ionic surfactants, which allows more precise control of the surface load and film stability. The selection of surfactants is of practical use in mixtures as stabilizers of colloid-dispersed system. Environmentally speaking, surfactants must be biodegradable, non-toxic, and insensitive to temperature, pH and water hardness. Non-ionic surfactants have no electric charge, making them resistant to the use of hard water as a solvent. They are excellent removers of fats and could be used in the formulation for decontamination. Synergy between anionic surfactants and non-ionic surfactants is used in emulsifiers. The fact is that the hydrophilic properties improve with increasing temperature and worsen with non-ionic surfactants, conducive to a considerable extent the temperature range in which the emulsifier acts and remain constant. [9, 10].

3. RESULTS AND DISCUSSION

Objects of the research are water solutions DV-2 (alkylphenolpolyglycol ethers, sodium threepolyphosphate and sodium sulphate), water solutions on Polyoxyethylene oleic acid ester ($CH_3(CH_2)_5-CH-CH_2-CH=CH(CH_2)_7COO$), Diethanolamide of coconut oil acids ($C_{(7+n)}H_{(15+2n)}NO_3$, $n=5,7,9,11,13,15$), Ethoxylated (22EO) natural unsaturated alcohol C16-C18 ($C12H_{25}(OCH_2)_nOH$).

The research has been conducted in a concentration range from three non-ionic surfactants in same concentration intervals (0 ÷ 0,35 %). Figure 2 is a chart of example correlation showing results of dependence $\sigma = f(c)$. Statistically processed data of correlations $\sigma = f(c)$ respectively for DV-2, Polyoxyethylene oleic acid ester, Diethanolamide of coconut oil acids, Ethoxylated (22EO) natural unsaturated alcohol C16-C18 at (2), (3) and (4) are given with regression equations in 20 °C temperature:

$$\sigma = 0{,}0728035 - 0{,}0240092C - 0{,}342106C^2 + 1{,}76384C^3 - 2{,}45455C^4 \quad (2)$$

$$\sigma = 0{,}0743255 - 0{,}202203C + 1{,}02675C^2 - 3{,}60133C^3 + 4{,}56606C^4 \quad (3)$$

$$\sigma = 0{,}0727516 - 0{,}249845C + 1{,}95208C^2 - 7{,}1351C^3 + 8{,}97424C^4 , \quad (4)$$

where: σ - surface tension, N/m; C - concentration, %.

The coefficients of higher values at (3) and (4) are due to the sharp decrease in surface tension at low concentrations.

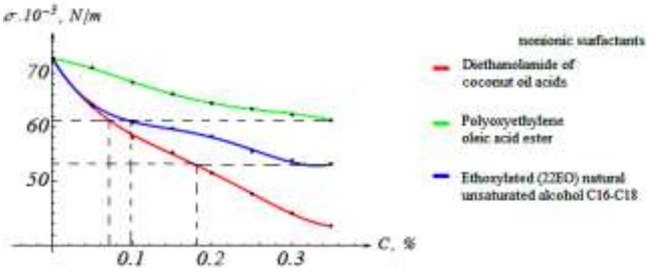


Fig. 2 Surface tension versus concentration of nonionic surfactants

The statistical treatment from the graphic interpretation shows that the surface tension of Diethanolamide of coconut oil acids has the lowest values in the concentration range of 0.1% to 0.35%. Polyoxyethylene oleic acid ester has no significant reduction of the surface tension in concentration range and more prolonged dissolution in water as compared to other surfactants in this experiment. Ethoxylated (22EO) natural unsaturated alcohol C16-C18 reduces the surface tension 2,5 times more than Polyoxyethylene oleic acid ester at 0,1 % ÷ 0,35 % concentration interval. Polyoxyethylene oleic acid ester reduces surface tension 0,8 times than Ethoxylated (22EO) natural unsaturated alcohol C16-C18.

Figure 3.3 shows the graphic example correlation showing results of dependence $\sigma = f(c)$ on DV-2 and Diethanolamide of coconut oil acids. It shows surface tension substances are similar in concentration range.

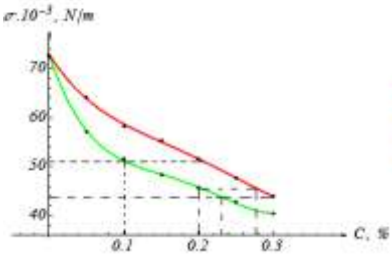
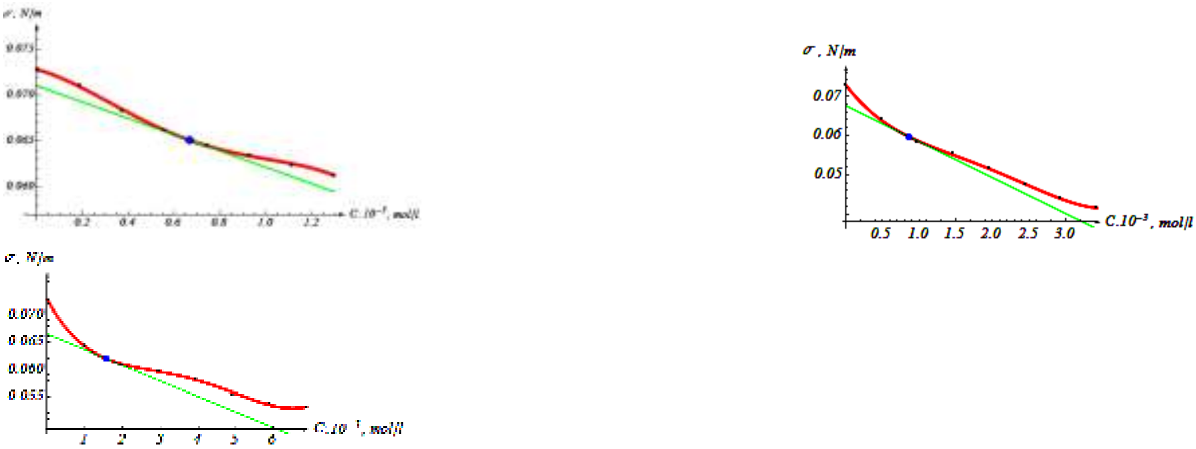


Fig. 3 Surface tension versus concentration of DV-2 and Diethanolamide of coconut oil acids.

If you use a DV-2 in concentration range 0,1 % and 0,2 % respectively, may be replaced with diethanolamine based fatty acids in concentration not less than 0.28%. Non-ionic surfactants are tested in a concentration range of 0 to 0.35%. The values obtained for surface activity are: Polyethylene ester of oleic acid (-8.3215), diethanolamine based fatty acids (-9.1274), ethoxylated unsaturated alcohols (-2.8606).



a) b) c)

Fig. 4 Function $\sigma = f(c)$ applicable to graphically determine the surface activity a) Polyoxyethylene Oleic Acid Ester; b) Diethanolamide of Coconut Oil Acids; c) Ethoxylated (22EO) Natural Unsaturated Alcohol

CONCLUSION

By graphical differentiation of the concentration dependence of surface tension using the supplied software product obtained numerical values for surface activity of decontamination solutions, which are the basis for qualitative and quantitative evaluation of the wetting power.

1. It was found that for decontamination the most useful are aqueous solutions of detergents based on sodium salts of alkyl derivatives (10 ÷ 16 carbon atoms) benzenesulfonic acid with a concentration of 0,2% ÷ 0,35%.The above stated empiric correlations of surface tension and concentration can be applied after statistic processing of experimental results.
2. In solutions for special handling different substances may be used and compositions lowering surface tension after a preliminary quantitative and qualitative assessment of their wetting ability%.
3. The proposed empirical correlations of surface tension concentration after statistical processing of the experimental results are applicable to the conduct of special treatment

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