SURFACE ACTIVITY OF SOLUTIONS FOR ELIMINATING RADIOACTIVE CONTAMINATION

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Abstract: *Surface activity of water solutions,* surfactants*, has been calculated on the base of concentration dependence of surface tension. Compounds for deactivation, based on synthetic detergents in different concentration scales have been offered.*

Keywords: SURFACE TENSION, SURFACTANTS

1. Introduction

The deactivating 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 solutions wettability and it is also a temperature dependent quantity. It has been defined by Gibbs absorption isotherm.

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

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

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 objective of this research is to be carried out comparative analysis on the wettability of two kinds of solutions: on the one hand - water solutions, containing DV-2, and on the other hand water solutions on synthetic detergents, which can be used for deactivation in different temperature and concentration interval.

2. Measurement Methodology and Research Object

Objects of the research are water solutions DV-2, water solutions of SHTAMEX, or powder-like synthetic detergents on the base of sodium salt of alkyl derivatives of benzene sulphoacid (containing 10-16 carbon atoms).The names – synthetic detergents SD „T" [4] and SD „B" [5] are introduced figuratively. Their components are given in Table1.Shtamex is a composition which is applicable in extinguishing fires by Fire Security and population protection.

Table 1: Synthetic detergents components.

Ingredients of SD "B"	Ingredients of SD "T"
- 5÷15% sodium salt of alkyl derivatives of benzene sulphoacid (containing C $_{10-16}$) - 10÷20% sodium carbonate - 1÷ 5% C$_6$H$_8$O$_7$/CH$_2$COOH-C(OH)COOH-CH$_2$COOH 5 ÷ 15% sodium silicate	- 5÷15% sodium saltof alkyl derivatives of benzene sulphoacid (containing C $_{10-13}$); - 5÷15% sodium carbonate; - <5% polyacrylic acid; - 5÷15% sodium silicate.

The research has been conducted in a concentration range from 0,1% to 0,35%. To calculate the surface activity it is necessary to be aware of the correlation $\sigma = f(C)$, which can be received experimentally.

Defining surface tension is completed through the method of maximum pressure while blowing a bubble from the capillary. [1,2,3]. The correlation between surface activity and temperature is fixed indirectly using the data of surface tension dependence on temperature. Heating the samples of experimental solutions is realized indirectly with heated in thermostat water, used as heat carrier. [1, 2]

The amounts of studied objects' surface activity are defined with graphic differentiation of $\sigma = f(C)$ correlation, applying computer platform[6]. Figure 2 is a chart of example correlation $\sigma = f(C)$, showing:

$$(2) \qquad tg\varphi = \frac{\partial \sigma}{\partial C} = g,$$

where: g - surface activity; $\partial \sigma$ -infinitely small change in surface tension, ∂c - infinitely small change in concentration.
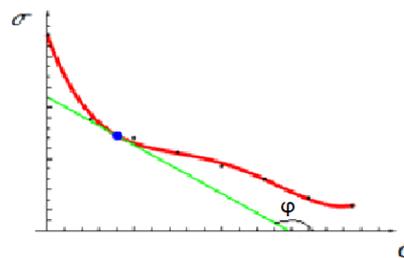

Fig. 1 *Graphic chart $\sigma = f(c)$ for defining surface activity of solutions.*

3. Results and discussion

Fig. 2 illustrates correlations $\sigma = f(c)$ for DV-2, SD „T", SD „B" and "SHTAMEX" at temperature of 20˚C.Statistically processed data of correlations $\sigma = f(c)$ [6] respectively for DV-2, SD „T", SD „B" and „SHTAMEX" at (3), (4), (5) and (6) are given with regression equations:

$$(3) \qquad \sigma = 0{,}073 - 0{,}072.C + 0{,}539.C^2 - 2{,}842.C^3 + 3{,}849.C^4$$

$$(4) \qquad \sigma = 0{,}073 - 0{,}215.C + 1{,}061.C^2 - 3{,}389.C^3 + 4{,}153.C^4$$

$$(5) \qquad \sigma = 0{,}072 - 0{,}449.C + 3{,}457.C^2 - 12{,}776.C^3 + 16{,}849.C^4$$

$$(6) \qquad \sigma = 0{,}072 - 0{,}027.C - 0{,}010.C^2 - 0{,}001.C^3$$

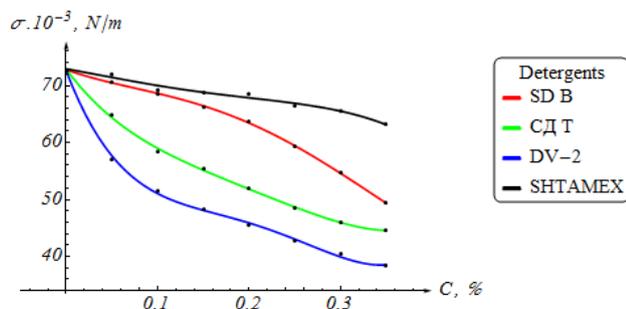where: σ - surface tension, N/m; C - concentration, %.

Fig. 2 Dependence of surface tension on detergent concentration in deactivating solutions.

The results, received after graphic differentiation of dependences Fig.2, give the amounts of surface activity, shown in Table2.

Table 2. Surface activity of detergent solutions

detergent / t, °C	DV-2	SD „T"	SD „B"
10°C	-81,0171	-64,8325	-50,494
20°C	-82,5559	-64,8457	-56,38
30°C	-82,6505	-65,8962	-60,4664
40°C	-83,8558	-66,8449	-66,6501

Experiments have been conducted in temperature interval from 10°C to 40°C, which is the most suitable for eliminating consequences caused by radioactive contamination. Figure 3 shows the correlation between surface activity and the temperature of synthetic detergents SD"T", SD"B' compared to DV-2.
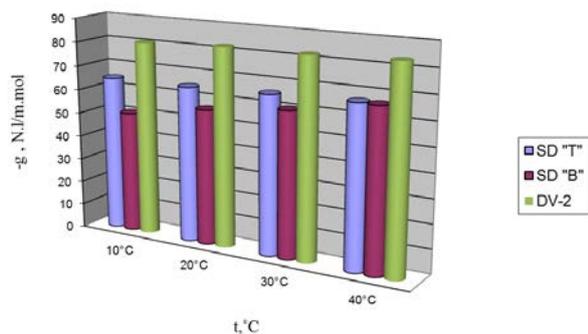

Fig. 3 Dependence of surface activity on temperature of different synthetic detergent solutions.

It is clear from table 2 and fig.3, that the surface activity is lower than that of DV-2, which means that their concentration in deactivating solutions is to be increased in relation to that of DV-2 When temperature is 40°C it does not influence the detergents significantly.

It is obvious from the histogram fig.3, that surface activity of DV-2 has the highest absolute value in comparison to synthetic detergents, object of the research. SD „T" is adsorbed on the surface 18,9% less than DV-2 at 20°C surface activity of SD „B" is 45 % lower than that of DV-2.

4. Conclusion:

1. With the usage of graphic differentiation of correlation between concentration and surface tension and the help of applied software product numerical values of deactivating

solutions surface activity have been received which also serve as a base for quantitative and qualitative evaluation of their wettability.

2. It has been determined that water solutions of detergents based on sodium salt of alkyl derivatives (with 10-16 carbon atoms) of benzene sulphoacid with concentration 0,2 % ÷ 0,35 %. Are applicable for deactivation.

3. The above stated empiric correlations of surface tension and concentration can be applied after statistic processing of experimental results.

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