DETERMINATION OF ANIONIC SURFACE ACTIVE AGENTS CONTENTS IN CLEANING AND WASHING PREPARATIONS

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Task VIII-S

DETERMINATION OF ANIONIC SURFACE ACTIVE AGENTS CONTENTS IN CLEANING AND WASHING PREPARATIONS

I. Aim of the task

The aim of the task is experimental determination of the anionic surface active agents contents in shampoos, bath and dishwashing liquids and washing powders.

II. Introduction

1. Characterization and structure of surface active agents:
   a) types of hydrophilic and hydrophobic groups,
   b) localization of hydrophilic groups in the particle,
   c) classification of surface active agents due to the chemical nature of functional groups.
2. Properties of surface active agent solutions.
3. Technological properties of surface active agents:
   a) foaming,
   b) solubilisation,
   c) emulsifying,
   d) wetting,
   e) dispersing.
4. Practical use of surface active agents.
5. Environmental protection - removing of surface active agents from municipal and industrial wastewaters.

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III. Theory

III. 1. Structure of surfactants

Surfactants or surface active agents are compounds exhibiting surface activity which means that dissolved in a liquid (particularly in water), even at very low concentration, they reduce their surface or interfacial tension as a result of adsorption at the interface. Adsorption at the boundary between any two immiscible phases is a result of **amphiphilic** structure of surface active agents. Amphiphilic substances in their asymmetric structure have a polar part – hydrophilic (lyophobic) and nonpolar – hydrophobic (lyophilic) and therefore they show different behaviour towards polar and nonpolar phases [1].

The following figure shows a diagram of the surfactant molecule:

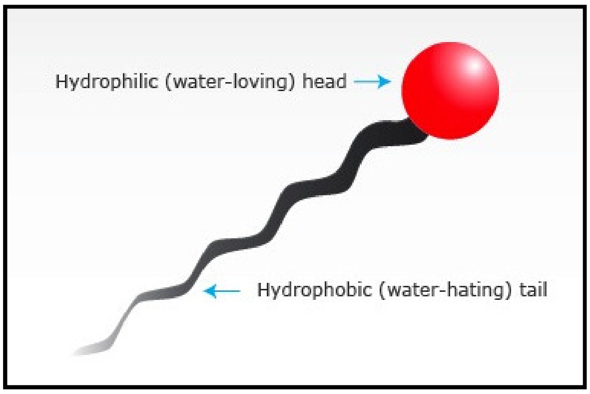


Fig. 1. Schematic structure of molecule of surface active agent [4].

The polar (hydrophilic) part of the surfactant molecule has a high affinity for water and other polar liquids. Its presence in the structure of surfactants makes them dissolve in polar liquids. The chemical structure of this part of the molecule also influences on the ability of the whole molecule of dissociation in aqueous solutions. The hydrophilic part is most frequently a water-soluble organic salt. In the molecules of classical surfactants the hydrophilic part is an acid or basic residue and its presence in the structure of surfactants gives them the capacity to dissolve not only in water but also in other polar solvents.

The most important **acid groups** in the structure of surfactant molecules are:

- carboxylate group: –COOH,
- sulfonate group: $–SO_3H$,
- sulfate group: $–OSO_3H$,
- phosphate group: $–OPO(OH)_2$.

The most important **basic groups** in the surfactant molecules are:

- primary amine group: $–NH_2$,

- secondary amine group: –NHR,
- tertiary amine group: $–NR_2$,
- quaternary amine group: $[–NR_3]^+$,
- pyridinium group: $[–NC_5H_5]^+$.

A lot of groups in the structure of surfactant molecules play a role of **linking groups** which connect different parts of the molecule. Such groups can be, for example:
– ester group: –COO–,

- amide group: –CONH–,
- imine group: –NH–,
- ether group: –O–.

Surfactant molecules can also include other **hydrophilic groups which do not form salts** and the most common are:

- alcoholic group: –OH,
- thiol group: –SH,
- ethoxylate group: $–CH_2CH_2O–$,
- propoxylate group: $–CH(CH_3)CH_2O–$.

The nonpolar (hydrophobic, lyophilic) part of the surfactant molecule has a high affinity for nonpolar liquids and no affinity for water. The presence of the nonpolar group in the molecules of surfactants enables their dissolution in oils and other nonpolar liquids.

Generally, the lyophilic part of the surfactant molecule is a long-chain hydrocarbon residue (mostly containing from 8 to 18 carbon atoms), which may be:

- unbranched – such as in the case of fatty acids, natural fats, and also their derivatives,
- branched – in the case of hydrocarbon residues of petroleum origin or synthetic origin,
- constructed of aromatic hydrocarbon with long alkyl chain.

The hydrophilic groups in the structure of surfactant molecules are linked directly with the hydrophobic part of molecule but sometimes they are linked with the hydrophobic parts by another group – **the intermediate one**.

III. 2. Criteria for the classification of surfactants

The surface active agents are a very great and varied group of chemical compounds and therefore there are several types of criteria according to which the classification of surfactants is carried out. Most commonly, surfactants are classified according to their chemical structure and functional properties [3].

III. 2.1. Classification of surfactants according to their chemical structure

Surface active agents are classified based upon the nature of the hydrophilic "head-group" which largely determines their properties and applications. There are **non-ionic surfactants** which have no charge groups in their head and **ionic surfactants** in which the head carries a net charge. Ionic surfactants are divided into anionic and cationic surfactants. The following figure shows the structures of some ionic and nonionic surface active agents:

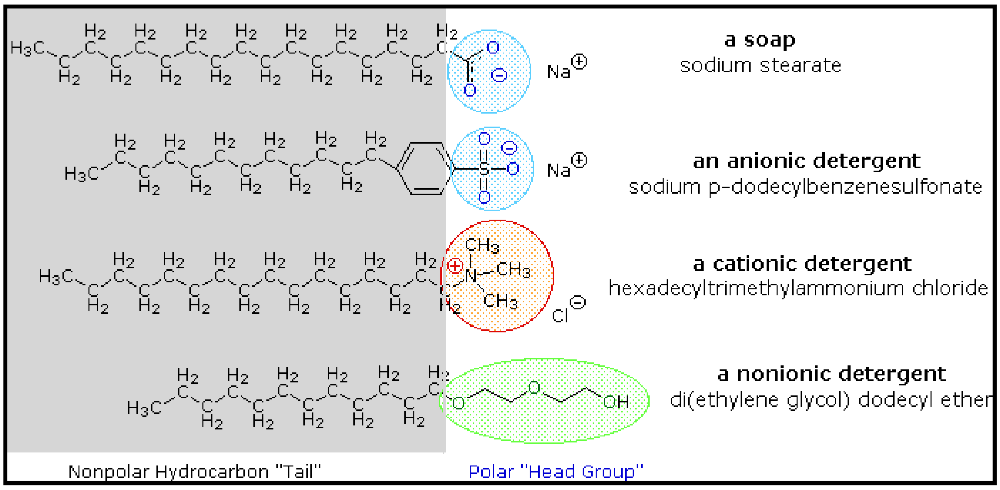


Fig. 2. Schematic structures of surface active agents [5].

Anionic surfactants – the surface-active portion of the molecule bears a negative charge, such as: ionized carboxyl group, sulfonate group or sulfate group; The examples of anionic compounds: sodium dodecyl sulfate (SDS), sodium palmitate.

Cationic surfactants – the surface-active portion bears a positive charge, such as: alkylammonium cations; The examples of cationic compounds: cetyl trimethylammonium bromide (CTAB).

Zwitterionic surfactants – both positive and negative charges can be present in the surface-active portion; The examples of zwitterionic compounds: long-chain aminoacid, sulfobetaine.

Nonionic surfactants – the surface-active portion bears no apparent ionic charges, such as: sugar groups (sorbitol, glucose), polyoxyethylene groups; The examples of nonionc compounds: $C_{10}H_{21}(OCH_2CH_2)_8OH$, $C_{12}H_{25}(OCH_2CH_2)_8OH$.

III. 2.2. Classification of surfactants according to the source of raw materials

Taking into account the origin of raw materials used for surfactants production they can be divided into two groups:

- products based on raw materials coming from renewable sources,
- products based on raw materials coming from non-renewable sources.

Raw materials coming from non-renewable sources which are used in the manufacture of surfactants are mainly: petroleum, hard coal, natural gas. Raw materials coming from renewable sources which are used in the manufacture of surfactants are mainly: vegetable oils, animal fats, protein hydrolysates, sugars.

Not long ago the basic raw materials for the production of surfactants were animal fats and therefore the location of factories of surfactants was not dependent on the location of sources of raw materials. With the increase of demand for surfactants vegetable oils and petroleum derivatives began to dominate in their production. New factories were opened close to oil refineries, for example: the factory UNGER Fabriker in Norway, the factories McIntire and STEPAN in the USA and close to huge oil palms (*Elaeis guineesis*) and coconut palms (*Cocos nucifera*) plantations located in Africa, Brasil and southeast Asia, where there were built some factories, for example: Th. Goldschmidt and KAO.

III. 2.3. Classification of surfactants according to their impact on the environment

Due to the impact on the environment surfactants can be divided into the following groups:

- chemodegradable,
- biodegradable,
- hardly-degradable,
- non-degradable.

This type of classification is rather arbitrary because it is based on the present state of knowledge related to the presence (in the environment) of the factors allowing decomposition of surfactant molecules into simpler compounds. Such decomposition is possible chemically (bonds susceptibility to hydrolysis), photolytically (bonds susceptibility to photodegradation), biologically (with participation of relevant enzymes).

III. 2.4. Classification of surfactants according to their technological properties

Taking technological properties and application of surfactants into account they can be divided into the following groups:

- wetting agents,
- dispersants,
- foaming agents,
- washing agents,
- emulsifiers,
- anti-emulsifiers,
- solubilisers.

Surfactants are a very large group of substances of natural or synthetic origin and they are used in many fields of human life (industry, agriculture, environment protection, medicine, pharmacy). So much interest of surfactants is due to their high surface activity which is manifested not only by reducing the surface and interfacial tension but also by good wetting, cleaning, washing (dirt removal and solubilisation, which means facilitating the dissolution of poorly soluble substances) and emulsifying (dispersion of water-insoluble substances to the form of emulsion) abilities. Surfactants are used to create stable foams and emulsions (Fig. 3).

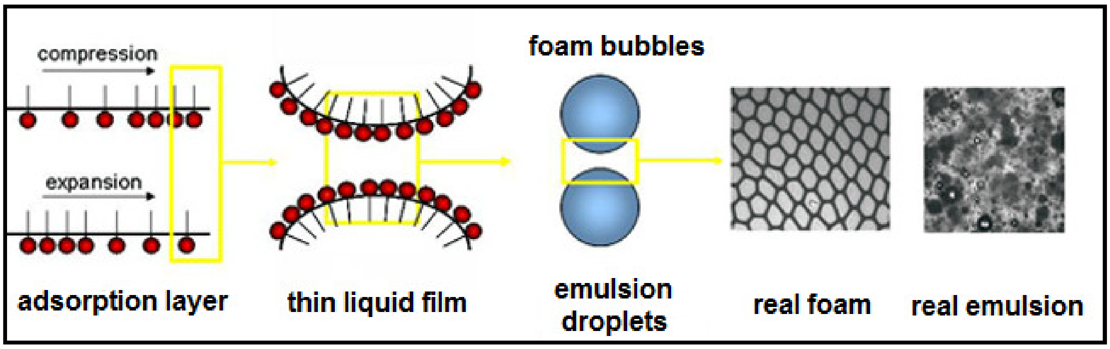


Fig. 3. The formation of stable foams and emulsions [8].

Detergents are a slightly smaller group of preparations or products ready for use, which are applied in washing and cleaning processes (typically with the formation of foam). Detergents are used in cosmetics and household chemicals, because their aqueous solutions are characterized by excellent washing ability which is intensified due to the reduced interfacial tension at the water-dirt interface. Detergents are components of washing powders and cleaning liquids. They occur in personal care agents, in soaps, shampoos, bath liquids, shower gels and hair conditioners.They are also a group of additives which give functional properties for final products including: anti-electrostatic, anti-corrosive, antimicrobial, antifungal, anti-mildew and preservation properties.

The most common surfactants used in practice are anionic surface active agents because they have very good cleaning and washing properties and capacity of dirt dispersion, therefore their production is the largest. Good washing agents must contain from 10 to 30% of anionic surface active agents and dishwashing liquids at least – 8%. This is similar in the case of shampoos and bath preparations. Shampoos with the 7% content of anionic surface agents are weak, with 9–11% content are quite good but the best shampoos have ~ 15% of anionic surface agents. The most important representative of this group of compounds are sodium salts of sulfated ethoxylated lauryl alcohol and sodium dodecylbenzenesulfonate.

Cationic surface active agents do not possess cleaning and washing properties and therefore they are added to cleaning products but only in a small quantity. They have very good anti-electrostatic properties and therefore they are used in production of washing preparations, as well as for those conditioning woven and knitted fabrics and also in cosmetic industry (in agents for hair conditioning).

III. 3. Solubilising properties

Solubilisation is a process in which an aqueous solution of surfactant, at a concentration above the critical micelle concentration, dissolves various hydrophobic substances (mainly organic) and the resultant solutions are transparent. In this case a solubiliser in a surface active agent (Fig. 4). A core of a micelle has liquid-like solvent properties and it can dissolve nonpolar compounds. Solubilisation of alkanes leads to the formation of a microemulsion of the oil in water type (type O/W).

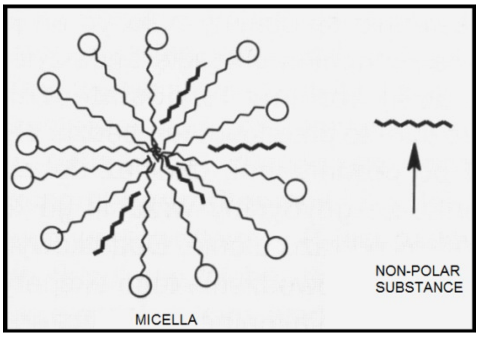


Fig. 4. The alkane solubilisation in the core of the ionic micelle [9].

The solubilisation can be observed, for example: during the process of washing. The next picture (Fig. 5) shows a scheme of the process of dirt removal from fabric using the surfactant solution:

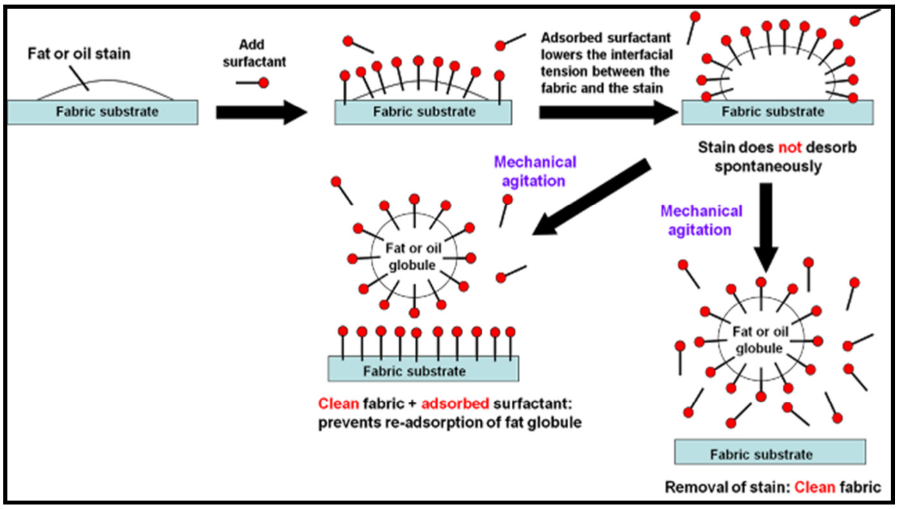


Fig. 5. The scheme of particle of dirt detachment from the fabric surface [10].

The detergent solution, due to its surface activity, reduces interfacial tension and at first it wets the surface because it penetrates all the capillaries, where the water itself can not reach. As a result of this action, the adhesion of dirt (organic and inorganic substances insoluble in water) to the surface decreases. In the next step dirt, insoluble in water, passes to the solution: liquid dirt is emulsified or dissolved in micelles and dirt in the solid form is dispersed. Effectiveness of the detergent depends on the time in which the emulsion state or the suspension state is maintained because then the dirt is not re-deposited on the fabric. Foam plays an important role in the process of preventing from dirt re-deposition. An important role in the washing process is also played by electrostatic repulsion forces when molecules of dirt and surface of fiber get the same charge. In the sites on the fiber from which the molecules of the dirt are detached, detergent molecules appear, immediately which prevents from re-deposition of dirt on the fabric. The separated particles of dirt are surrounded by molecules of surface active agent and "hang" in the wash liquor.

III. 4. Hair care

Shampoo is one of the most important personal care agents. In the case of shampoos the most important criterion for assessing their functional properties is their effect on hair and on skin of the head. Shampoo should be good quality, convenient to use and safe for the user and the environment. The role of shampoo is to clean hair and skin of the head from tallow, exfoliated epidermal, dirt and the residues of cosmetics. Besides cleaning properties most shampoos have also other functions, for example, curative, conditioning or staining. There are shampoos for different types of hair, for example, for dry hair, for greasy hair and also for delicate or coloured hair. Shampoos can be produced in different forms, as clear liquids, liquid creams, gels or powders (dry shampoos).

Shampoo can contain from a few to several components. It is composed of the basic and auxiliary surface active agents and various types of additives. Basic surface active agents provide cleaning effects and foam formation, while an adjunct includes modifiers, increase the effect of washing and stabilizes the froth. In the composition of shampoo there are also some adjuncts, such as dyes, preservatives and fragrance agents, conditioners, anti-dandruff agents, and others, which improve the product properties.

III. 4.1. Shampoo recipe

III. 4.1.1. Surface active agents

The main ingredients of shampoos are surface active agents and they require appropriate choice. The basic ingredients of shampoos are anionic surface active agents. The first synthetic, anionic surface active agents in the shampoos were **alkyl sulfates** of the formula:

$$ROSO_3Na$$

R - alkyl chain, containing from 10 to 12 carbon atoms

They are obtained by the reaction of alcohols with $ClSO_3H$. Their production is fast and cheap. The most often used is a mixture of derivatives of lauryl alcohol and myristyl alcohol in the form of sodium, ammonium or alkanol ammonium salts. They possess good washing and foaming properties and they are easy to rinse. Their disadvantage is poor solubility in cold water, limited ability to thicken the shampoo and irritating effect on the skin.

Polyethoxylated fatty alcohol sulfates of the formula:

$$[R(OCH_2CH_2)_nOSO_3]^- Me^+$$

$Me^+ = Na^+, Mg^{2+}, NH_4^+$

R - alkyl chain (C_{10}–C_{14}); n=2–5

They are well tolerated by the skin, have good washing and foaming properties. The increase in the degree of ethoxylation (*n*) reduces irritating effect on the skin and improves foaming properties and solubility in water. Sodium and magnesium salts are available. Magnesium salts are milder for the skin, but they have worse cleaning properties.

Another group of surface active agents used in shampoos are **zwitterionic surfactants, betaine and imidazoline derivatives**, characterized by mild effects on the skin, they also form abundant foam, and they have good wetting and cleaning properties. They can be mixed with electrolytes and other surface active agents, they are non-toxic and non-irritating. The additional surface-active compounds with washing properties which are added to shampoos are for example the condensation products of fatty acids with proteins of the formula:

```
R–CONH–CH–COOH
        |
        R
```

III. 4.1.2. Auxiliary agents

Besides surfactants in the shampoo composition there are also auxiliaries, such as consistency regulators, which increase viscosity by increasing the size of the micelle and creating the gel structures due to swelling in the water phase.

The following thickening agents are used in cosmetics:

- **hydrocolloids** – natural resins (arabic gum, tragacanth), synthetic resins (ethyl cellulose, hydroxyethyl cellulose, carbopols); viscosity of resins depends on temperature, therefore their concentration must be properly selected;
- **electrolytes**, for example: sodium chloride (or sulfate) or ammonium chloride (sulfate), they increase viscosity particularly in shampoos which contain sulfates al-

kyloxyethylated and with the increase of electrolyte concentration there can occur the salting out effect which causes the system instability;

- **alkanolamides** – mono- and diethanolamides of fatty acids and their derivatives, which are built into micelles; their effect is intensified in the presence of electrolytes;
- **ethoxylates thickening agents** – ethers and esters with a high degree of ethoxylation.

Another group of consistency regulators in shampoos are polyhydric alcohols of low molecular weight such as propylene glycol and glycerin.

The other components of shampoos are stabilizers, such as:

- **preservatives** – mixtures of esters of *p*-hydroxybenzoic acid,
- **antioxidants** – ascorbic acid, tocopherols, BHA,
- **complexing agents** – ethylenediaminetetraacetic acid, nitrilotriacetic acid salts, phosphates,
- **UV filters** – benzophenone derivatives,
- **buffering substance** – buffers: citrate, lactate, phosphate,
- **solubilisers, dispersants**.

The auxiliary agents are also:

- **opacifying agents**, mainly derivatives of stearic acid; degree and type of turbidity depends on the type and size of particles which cause this turbidity, their solubility in the shampoo, reflectance, concentrations, and technology of shampoo production;
- **fining agents**, such as such isopropyl alcohol, ethyl alcohol or butyl alcohol, propylene glycol or hexylene glycol; turbidity of the liquid shampoos is associated with the formation of magnesium or calcium soaps caused by the use of hard water and it can be reduced or completely eliminated by the addition of sequestering agents, such as pyrophosphate or tripolyphosphate;
- **fragrance agents**, their role is masking the characteristic, usually greasy smell of the shampoo and giving it the own, pleasant aroma.

The last group of compounds added to shampoo are special additives which exhibit special effects: *conditioning, regenerating, healing*. The most commonly used raw materials with a conditioning or regenerating effect are: plant extracts, proteins (silk, soybean, keratin), vitamins (A, E, F, C, D-panthenol), vegetable oils (castor oil, almond, peach, jojoba), lanolin, lecithin, ceramides or silicones. Among the compounds of medicinal nature, anti-dandruff agents are very important.

III. 5. Washing process

In the process of dirt removing – laundry, washing bath is usually an aqueous solution of suitable washing powder which comprises many different components interacting with fabric, dirt and each other. Some soils, such as salts, which are components of sweat, or sugars, are soluble in water, and their removal does not cause any trouble. However, the removal of other impurities (fats, dander, dust, stains from food, wine, tea, coffee, blood, etc.) requires the addition of various substances, which are washing powder components.

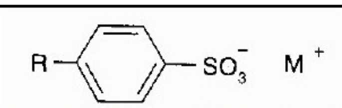
III. 5.1. Washing powder composition

Besides surfactants the modern washing agents include many other components. The composition of typical washing powder is as follows:

- anionic and nonionic surface active agents (from 8 to 25%),
- fillers, agents water anti-hardness (from 30 to 80%),
- agents preventing dirt deposition (from 0.5 to 2%),
- agents against washing machine corrosion (from 4 to 6%),
- optical brighteners (from 0.1 to 0.5%),
- active bleachers (from 20 to 30%),
- activators of active bleachers,
- stabilizers of active bleachers (from 1 to 2%),
- anti-foaming agents,
- enzymes,
- fragrance agents,
- dyes.

III. 5.1.1. Surfactants

The basic compounds of washing agents are surface active agents. A mixture of anionic and nonionic surfactants is typically used because of the **synergistic effect**, which consists in the fact that the adsorption, foaming and wetting properties of the mixture of these surfactants are better than for single surfactants. Most commonly surfactants used in the group of anionic surface active agents are sulfonic acid salts with a benzene group:



R - alkyl chain, containing from 10 to 12 carbon atoms

and as nonionic surfactants polyoxyethylene esters are used.

III. 5.1.2. Fillers

Another basic compound in the composition of washing powder is filler. Usually, several various substances are used and their main function is water softening. The water hardness is due to the presence in water of dissolved salts, mainly calcium salts and magnesium salts, and of a small amount of cations: Fe^{3+}, Mn^{2+}, Al^{3+}, Zn^{2+}. Pollutants are released in the chemical reaction or above the saturation point at the same temperature. At first there are precipitated the compounds which have the smallest solubility product under the same conditions. Calcium ions render the laundry difficult because they bind to the anionic surfactants and insoluble salts deposit on the fabric surface, which results in grayness after washing. In hard water the ability of the surfactant to emulsify fats and form foam diminishes. Scaling on the heating elements of the washing machine reduces heat flow and leads to their burnout. The role of fillers is to control pH of washing bath because anionic surfactants are more efficient in the alkaline medium.

The first known filler was sodium carbonate, commonly known as soda. Na_2CO_3 binds calcium ions in the form of hydrogen carbonate, which remains in solution even at high temperatures. The other fillers which soften the water are polyphosphates, usually of the $Na_5P_3O_8$ type. They are very effective but they have a fundamental drawback – they are harmful for the environment. Therefore, polyphosphates should be replaced in the washing powders composition. Sodium silicate, zeolite A (aluminosilicates of the general formula $Na_2O \cdot SiO_2 \cdot 4.5H_2O$), organic compounds which bind calcium ions in the form of water-soluble complexes (chelates) - amino acetic acid, ethylenediaminetetraacetic (EDTA) acid, citric acid, tartaric acid (all as sodium salts) are used to replace for polyphosphates. On the packaging of the washing powders, the fillers are known as chelating, complexing or sequestering agents. Moreover, copolymers and water-soluble polymers (polyacrylic and polyethylenemaleic acids) in the form of sodium salts are used in washing powders. They possess the ability of calcium ions complexation. Additionally, sodium sulfate and sodium chloride are included in washing powders composition.

III. 5.1.3. Chemical bleaches

Bleaches are used in washing powders and in dishwashing agents. Their role is to increase efficiency of removing color-dirt components from textiles and tablewares. Their important function is also the disinfection of dirty materials which means a significant reduction of biological contaminants, especially pathogenic microorganisms.

Based on the chemical structure bleaches can be divided into:

- peroxy bleaches (sodium perborate – $NaBO_3 \cdot 4H_2O$, sodium percarbonate – $Na_2CO_3 \cdot 1.5\ H_2O_2$),
- hypochlorite bleaches (sodium or potassium hypochlorite).

A perhydroxyl ion $(OOH)^-$ is the bleaching agent and a disinfectant agent (as in the case of sodium percarbonate), formed as a result of tetra or monohydrate of sodium perborate dissolution in an alkaline wash liquor. The decomposition of sodium perborate and sodium percarbonate in alkaline cleaning and washing baths as well as the formation of the perhydroxyl ion can be presented in the following form:

$$NaBO_3 \cdot 4H_2O \Rightarrow Na^+ + BO_2 + H_2O_2 + 3H_2O$$
$$NaBO_3 \cdot H_2O \Rightarrow Na^+ + BO_2 + H_2O_2$$
$$2Na_2CO_3 \cdot 3\,H_2O_2 \Rightarrow 4Na^+ + 2CO_3^{2-} + 3H_2O_2$$
$$H_2O_2 \underset{\text{alkaline environment}}{\Leftrightarrow} (HOO)^- + H^+$$

The perhydroxyl ion reacts with organic dyes and oxidizes them to colourless and soluble in water products, which are then easily removed from the surface of the fabrics or dishes during cleaning or washing. Moreover, the perhydroxyl ion has very good properties from a practical point of view (antibacterial, disinfecting and deodorizing properties). As a result of the thermal decomposition from sodium perborate, sodium borate is formed, and in the case of percarbonate – sodium carbonate. Both of these compounds play an additional (advantageous) role of co-fillers in the laundry or in the dishwashing process.

III. 6. Methods for quantitative determination of surfactants

With quick development of production and application of surface active agents, their concentration in wastewaters and ground-waters as well as surface waters has increased. Due to the rapid development of surfactants production and their application in many areas of human life, their concentration in wastewaters and groundwaters as well as surface waters still increases. Because of the environment pollution, there is a need to develop effective, sensitive, cheap and fast methods for the quantitative determination of surfactants. In the case of single surface active agents occurrence there are many methods for their determination, when surfactant mixtures, especially ionic ones are present, it is necessary to separate them from each other before determination.

Five basic types of methods for surfactants determination:

– gravimetric methods,
– titration methods,
– spectrophotometric methods,
– electroanalytical methods,
– chromatographic methods.

Anionic-cationic titration is one of numerous titration methods used for quantitative determination of anionic surface active agents. It involves the reaction of neutralization of cationic compound by an anionic compound (or vice versa) in the two-phase system: chloroform-water. For titration, there is used a composite indicator, which is composed of a cationic dye (diimide bromide) and of an anionic dye (disulfine blue VN). This system gives a very clear change of chloroform layer from pink-red to blue. A solution of Hyamine 1622 is used as the cationic agent for titration.

IV. Experimental

A. Equipments and materials

1. Equipment:

- burette – 25 cm^3,
- Erlenmeyer flask – 100 cm^3 – 4 u,
- volumetric pipette: 10 cm^3 – 1 u,
- beaker – 100 cm^3 – 1 u,
- plastic container – 2 u,
- funnel – 2 u,
- wash-bottle.

2. Materials:

- composite indicator – diimide bromide and disulfine blue VN solution in
- 10% ethyl alcohol,
- Hyamine 1622 aqueous solution of the concentration $4 \cdot 10^{-3}$ M,
- sodium dodecyl sulfate (SDS – M_{SDS} = 288.38 g/mol) aqueous solution of the concentration $4 \cdot 10^{-3}$ M,
- chloroform,
- shampoo,
- liquid bath,
- dishwashing liquid,
- washing liquid,
- washing powder.

B. Tasks

1. Determination of the titer of a solution of Hyamine 1622 using a solution of SDS.
2. Preparation of the solutions of cleaning and washing preparations (shampoo, liquid bath, dishwashing liquid, washing liquid, washing powder).
3. Quantitative determination of anionic surface active agents in cleaning and washing preparations.

C. Methods

1. Determination of the titer of a solution of Hyamine 1622

In order to determine the titer of a solution of Hyamine 1622, take two samples of 12.5 cm^3 of sodium dodecyl sulfate solution of the concentration of $4 \cdot 10^{-3}$ M and pour into the Erlenmeyer flask, add 7.5 cm^3 of chloroform and 5 cm^3 of composite indicator. Perform the operation of titration of the prepared solutions with the solution of Hyamine 1622. Near the equivalence point the emulsion begins to fade and a pink layer of chloroform is created. Titrate until the complete disappearance of the pink colour and until the colour of the chloroform layer will be grey-blue. **The chloroform layer becomes blue in the case of the excess of reagent!!!** Determine the real concentration of Hyamine 1622 solution.

2. Preparation of the solutions of cleaning and washing agents

In a plastic container weigh 1g of shampoo, then pour a few cm^3 of distilled water into it and mix thoroughly. Pour out the content into a flask using a funnel with a capacity of 100 cm^3. Add distilled water to the mark. Thus prepared solution should be poured into the bottle labelled "shampoo". Perform the same operations for the bath liquid, washing liquid and dishwashing liquid. In the case of washing powder dissolve a sample of powder (0.5 g) in warm water (~ 50 cm^3) and pour into a 100 cm^3 flask. After cooling the solution, make it up with water to the mark. Pour into a bottle labelled "washing powder".

3. Quantitative determination of anionic surface active agents in cleaning and washing preparations

Take two samples of 12.5 cm^3 solution of detergent from the bottle, pour them into the Erlenmeyer flask, add 7.5 cm^3 of chloroform and 5 cm^3 of a composite indicator. Make titration in the same way as that of Hyamine.

Calculate the percentage content of the anionic surface active agent (X) from the formula:

$$X\,\% = \frac{(100/12.5)\cdot V \cdot c_m \cdot 10^{-3} \cdot M \cdot 100}{a}\,\%$$

$$X\,\% = \frac{0.8 \cdot V \cdot m \cdot M}{a}\,\%$$

where: V – the volume of Hyamine 1622 used for titration of the weighted amount of cleaning or washing agent [cm^3], c_m – the molar concentration of Hyamine solution [mol/dm^3], m – the molarity of Hyamine solution [mol], M – the average molecular weight of surface active agent [g/mol] (M = 348.5 g/mol), a – the weighted amount of cleaning or washing agent [g].