Moving liquid surfactant as a way of assessing the properties of surfactant, liquids and surfaces.

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Abstract.
In the study of surface phenomena of the main and only instrumentally-defined parameters are surface tension and wetting angle, including in the field of nanotechnology. These indicators were introduced more than 200 years ago, and any new inventions in this field was no more. The university developed a new method and device for determining the surface activity. The basis of the method and device is the use of video cameras to record the droplet size and changes on the surface of the liquid layer of known thickness from the impact of drops of surfactant (surfactant). Committed changes are then processed using computer software and calculated parameters, which can be characterized by a surfactant and surface properties, which is fluid and very liquid. Determine the surface tension or contact angle is not necessary. Measures of surface activity using the method and device are:
1. The amount of fluid that can move one kilogram of surfactant. The value of this index varies from tens of nanometers to hundreds of thousands of units. The indicator can be converted to energy units, joules.
2. The amount of fluid confined by a surface per unit time is calculated based on the first indicator, complements the characterization of surfactant and may be an indicator of surface characteristics and fluid.
3. propagation speed of the capillary and microwaves. This indicator complements the first two.

1. Introduction

Known methods for determining the surface activity using two instrumental parameters to be determined the surface tension and wetting angle. To determine them, developed a lot of ways. According to these parameters is judged on the ability of emulsifying agents is suspended, or form a foam [1].In addition, the solutions themselves surface-active substances are composed of self-assembled particles - micelles, which have dimensions of nanoparticles and the aptly Victor Balobanova are the miracle of nanotechnology [2].

And the contact angle and surface tension in certain conditions does not provide a sufficiently complete characterization of solutions on the surface activity of the impossibility of defining or low variability index determined by various conditions, such as substance concentration, temperature, use of substances inactive or do not alter the surface activity, etc. And improve the accuracy of
identification, such as surface tension requires a high purity of the material. In addition to defining the work of adsorption, wetting or spreading requires knowledge of other parameters, the definition of which is associated with significant complications or impossible to determine because of the lack of reliable methods to determine [1].

The introduction of surface-active substances (SAS) in the liquid alters the surface tension is not more than ten units, and the wetting angle from 0 to 180, therefore, share or identify surfactants on these indicators is practically impossible.

Particularly relevant is the separation and identification of substances with surface activity in the development and evaluation nanomotors using surface activity as the driving force, as well as to evaluate the surface properties obtained with the use of nanotechnology.

2. Experimental part

Determination of surface activity is carried out at the facility (see Figure 1). Detailed scheme of the setup is given in [3].

On the table with adjustable horizontal surface of a stack plate made of material 2, the properties of the surface which is necessary to investigate (in the diagram in Fig. 1 denotes an object - the drug). For retention on the test surface of a liquid layer, such as 0,1-1 mm thick, the material applied to the circumference of a hydrophobic substance, if liquid is polar, or hydrophilic substance, liquid or solutions of various substances, whose influence is necessary to investigate, not polar. Then set the camera 4 or a movie camera so that the restrictive line and the center of bounding shapes are clearly visible in the viewfinder and possibly cover the entire area frame (adjustment of image sharpness). After setting the image sharpness set line with a scale of 1 mm. And fix the camera for subsequent scaling measurements. Ruler set perpendicular to the optical axis of the lens fixing process chamber 4, exactly the diameter of the circle. After that line removed.

![Scheme 1. The general scheme of the installation.](image)

1. Desk with adjustable horizontal; 2. Object - a drug (investigated surface); 3. Camcorder to record the droplet size; 4. Camcorder to record changes on the surface of the object - a drug; 5. Pipette; 6. Indicator grid; 7. Illuminator.

In limited hydrophilic or hydrophobic substance circle made by the investigated liquid in an amount necessary to create a liquid layer thickness selected researcher.

Exactly over the center of bounding shapes, such as a circle, set the calibrated mass of the drop and capillary diameter tip pipette 5 so that a drop of it fell as far as possible the exact center of
the figure. Edge of the tip of the pipette set at a height of 4-30 mm. Illuminator 7 with flat grid 6, set so that reflected from the surface of the liquid image grid in the fixing chamber 4 was clearly visible.

The camera includes the fixation image, both to determine the drop volume at the time of separation from the capillary pipettes include a chamber 3, retaining a larger scale drop, and a drop of surfactant solution or the liquid is made into the center of the circle. Film frames, fixing the process of moving the liquid successively studied by determining the distance from the center of the fall of the drop to the ground «wave of displacement» and in accordance with the scale of the transfer of units of length. Similarly, define the diameter of the drop at the time of separation from a capillary pipette.

If you want to define or compare the properties of surfactants, we can use the «standard» surface, as which can be used hydrophobic heat-resistant film or writing paper, or paper with a modified surface, such as gelatin.

When working with paper on it cause the circle with the necessary internal diameter of the hydrophobic dye. Linewidth bounding figures 5 - 6 mm. Paper coated with a bounding shape (an object - a drug) are soaked in a solvent such as water for some time, say 10 minutes and put on the table, or stacked on his plane-parallel plate (thick glass). In this paper, straighten, and from beneath it removes the air, extruded through a glass tube with rounded ends, for example, pipette diameter of 10 - 15 mm, or other devices, such as roller glossing photos or cushion for straightening and pasting wallpaper. To the square of paper, limited deposited lines (circle, square), cause under investigation in the amount of liquid required to give a layer thickness is determined by the experimental conditions. In the center sets a pipette tip, include fixing the camera and make the center of the bounding shape of the object - a drug drop of the test surfactant. For more details see [4]

![Fig. 1. View of the surface after exposure to drops of surfactant «Equalizer», a concentration of 5 kg/m³. From left to right frame k5 - The fall of the drop, shot k16 - the largest radius of the displaced layer frame k77 - the closure of the funnel.](image1)

![Fig. 2. View of the surface after exposure to a drop of clean water. From left to right frame of k33 - a drop in flight, shot k34 - a drop fell formation of capillary waves, the frame k35 - scattering of waves, the frame k36 - the extinction of the wave.](image2)

Method illustrated by the following images in the figures. After touching a drop of surfactant solution (see Fig. 1 frame k5) on the surface of the liquid layer, a small «crater». From it in different directions begins to propagate the «wave of displacement» of the liquid, which after a time reaches the maximum displacement (see frame k16 in Fig 1). Then release part of the surface closes the liquid (see frame k77 in Fig. 1). On these images, Fig. 1 shows the process of moving the liquid surface-active substances called «Equalizer», a concentration of 5 kg/m³. Accordingly, frame k5, k16, k77 movie. The inner
diameter of the bounding circle of 122 mm. Water depth 0.5 mm. For comparison, Figure 2 shows the change in the water from falling a drop of clean water.

3. Determining the amount of fluid moved surfactant.

To determine the amount of fluid displaced by time-lapse unfolding find a frame corresponding to the maximum radius (diameter) of the displaced fluid layer and using standard computer programs, measure it. Figure 3 shows an example of the measurement.

After finding the radius is determined by the volume of displaced fluid, given its density. In this example, the density of water was equal to 1000 kg/m³. The volume of displaced fluid was found to be 9.4 x 10⁻⁷ m³. Water depth in the experiment was 5.0 x 4.10 m. In terms of mass of the displaced fluid was 0.00094 kg. When the surfactant concentration "EQUALIZER" 5 kg / m³ and 0.00229 m diameter drops of surfactant, that you move is equal to 3.15 x 8.10 kg. Then a specific amount of fluid displaced will be 29688.55 kg. One kg of surfactant can move 29.7 tons of water to a distance of 0.0244 m. This corresponds to work on a 7106.37 joules.

The amount of fluid displacement affects the size of the bounding shape and concentration of surfactant in the solution. Fig. 4 shows the results of a study on the influence of these parameters on the amount of fluid displacement surfactants.
4. Determination of surface properties

To determine the properties of the surface on which the liquid was, found time to reach maximum radius of travel by the number of personnel from the moment of touching a drop of surfactant liquid to a frame with the largest radius of movement. Knowing the frame rate, found the time between shots and multiplied by the number of frames to achieve the greatest range of fluid movement. Then multiplying by the time required to achieve the greatest movement of fluid, the number of displaced one kilogram of surfactant liquid, were found in surface. The results are shown in Fig. 5. The results presented show that the number of displaced fluid is changed, passing through a maximum which is reached at a concentration of 4 kg / m$^3$. Perhaps this is due to the properties of surfactant solutions, which vary significantly with increasing concentration and the formation of micellar nanostructures. [2]

5. Determining the properties of liquids

To determine the range distribution of the microwaves used by reflection indicator grid, which on the surface of the liquid is clearly seen in the movie. Excitation of the surface of the liquid was carried out with the falling water drops height of 0.02 m at the surface of the water.

Figure 6. Propagation of waves on the surface of the liquid third frame from falling drops of water.

poured into the restrictive circle on the paper surface. Different amounts deposited in the bounding circle of the liquid changes the thickness of the layer from 0.0002 m to 0.001 m on the surface of the water-cut paper. Changes occurring in the interaction of water droplets with surface layer of water was
fixed with a video camera. Then on the frame scan selected shots for the measurements of these observed changes. (See appendix) for this use standard computer programs WINDOWS. Similarly, there were at studying the effect of surfactant concentration on the velocity of the waves. Studies have shown that water droplets in contact with the surface water initially formed microwaves (see Fig. 6.) that move across the water with almost constant velocity (70 - 75) x10-2 m / sec. (See Figure 4) Completion of the microwave image of the indicator grid disappears. Formed and then great waves move over the surface of the liquid at a lower rate, on average, 32h10-2 m / sec. (See Figure 6) C increase in water depth range propagation of microwaves increases. Given the study of American astronauts, one can assume that microwaves are generated by vibrations of the surface water film whose thickness is 0.00015 m [5]. And their height (amplitude) may not exceed twice the thickness of the film.

The interaction of drops of surfactant with the surface water also causes the appearance of these two types of waves, however, larger wave, starting from the center of the fall of the drop, then move to the edges of the bounding circle is under the influence of «wave moving fluid» (see Figure 7. Mark with ). She seemed to be pushed in front waves and the trailing edge of the wave becomes steeper. This wave slows its movement when approaching the edge of the bounding circle, and the beginning of their movement reveals a surface on which the liquid (see Fig. 7. A tag) and «boundary layer» of fluid (see Fig. 7. In the tag, the line indicator grid are clearly visible), under the influence of the force field of this surface. Moreover, at low concentrations of surfactants and strong interaction with the fluid lying below the surface «wave moving fluid» rolled over the surface «boundary layer». He is brilliant at all times and determine the zone A free fluid is observed. The introduction of surfactant lowers the speed of propagation of large capillary waves. (Without the surfactant average speed of capillary waves, 32 x 10-2 m / s and with surfactant 20.5 x10-2 m / s) And microwaves are observed on the surface of large waves, because of what the indicator grid on the surface of the liquid is not visible (Fig. 6 and 7.) Large Wave «movement of the fluid» slow down when approaching the edge of the bounding circle to the (13-15) x10-2 m / sec. The speed of microwaves remains almost constant between 65 - 75 x10-2 m / sec. At this speed can be detected speed only twice during the passage of microwaves on the investigated surface. Microwaves quickly reach the restrictive circle.

The effect of opening the boundary layer of fluid wave displacement can be used to estimate the thickness of boundary layers and their visual observations. A property of microwaves to increase the range of distribution with increasing thickness of the layer of fluid can be used to estimate the thickness of the layer of water associated with the surface on which the liquid is, and this estimate of interaction energy of the liquid to the surface. Method for moving liquid surface-active agents are encouraged to use to characterize the properties of surfaces and identification of surfactant, including nanomaterials and in the metrology of nanomaterials.

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