Lodz University of Technology
Institute of Materials Science and Engineering

Laboratory 10

Determination of surface tension of liquids by stalagmometric method

Instruction for the Laboratory of Biophysics

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I. THEORETICAL INTRODUCTION

The formation of the droplets, which flows freely from the capillary, is dependent on the surface tension of the liquid. This phenomenon is used to determine the surface tension using stalagmometric method (method of counting drops). Stalagmometer (Fig. 1a) is a device made up of a glass bulb with marked above and below the bulb indicators designating specific volume of liquid, ended capillary. To measure the surface tension of the test liquid fill of stalagmometer and allow it to flow freely. During the formation of the drop in volume continuously increases. Thereby growing its weight Q.

At a time where the weight of drops of exceeds values of forces of surface tension (F) along a drop detached from a capillary(Fig. 1b). Begins the process of forming the next drop. The cross-section drops its place throat is a circle with a circumference of radius r l = 2πr. The value of the force F can be expressed as:

$$F = \sigma \cdot l = \sigma \cdot \mathbf{2} \cdot \pi \cdot r \qquad (1)$$

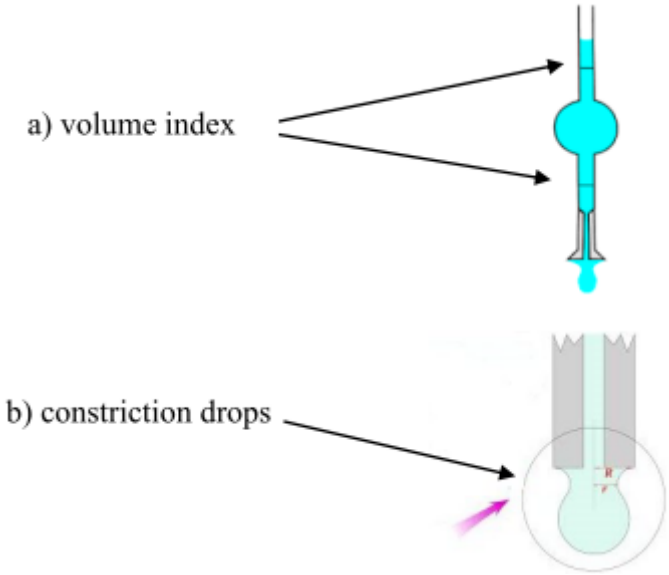

Fig.1 Stalagmometre with indicators of volume V of the bubble (a) and a drop forming at the end of the stalagmometre's capillar (b)

The weight of single drop (Q) can be determined by dividing the weight of the liquid contained in the volume (V) of the bubble stalagmometre by the number (n) of the formed droplets:

$$Q = \frac{d \cdot V \cdot g}{n} \qquad (2)$$

where:

d - density of the liquid

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g - acceleration due to gravity

We assume that at the moment separation drop from the capillary stalagmometer, the value of force F and the weight drops are equal:

$$\sigma \cdot \mathbf{2} \cdot \pi \cdot r = \frac{d \cdot V \cdot g}{n} \quad (3)$$

Surface tension is:

$$\sigma = \frac{d \cdot V \cdot g}{\mathbf{2} \cdot \pi \cdot r \cdot n} \quad (4)$$

Because it is difficult to measure the radius (r) of the throat of drop at the moment of detachment, the formula (4) does not apply to the determination of the absolute value of the surface tension.

Stalagmometric method is often used to measure the relative surface tension $\frac{\sigma}{\sigma_o}$, ie. to compare the surface tension of the tested liquid σ to surface tension of the standard liquid σ_o Assuming that the throats rays of standard liquid r_o and test liquid r are equal, the formula for the relative surface tension takes the form:

$$\frac{\sigma}{\sigma_o} = \frac{n_o \cdot d}{n \cdot d_o} \quad (5)$$

where:
n_0 - the number of drops of standard liquid,
n - the number of drops of the test liquid,
t_0 - density of the standard liquid
d - density of the test liquid

The presented considerations that the weight of the drop detachment from the capillary tube, and its volume depends on the surface tension of the liquid forming droplets.

II. . INSTRUCTIONS

1. The stalagmometre's capillary put inside the baker with distilled water. using a rubber bulb pump the liquid till the level of water will be above upper line.
2. Take the stalagmometre out from the baker \
3. Below capillary set the beaker
4. After removing the rubber bulb, begin observing the upper meniscus of the liquid. At a time when the meniscus is aligned with the upper line begin to measure time. Measurement finishes when the water surface is aligned with the lower line (n_0).
Measurement repeat 10 times.

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5. Calculate the mean n_0 and the maximum error of n_0
6. Wash the stalagmometre by tested liquid
7. Repeat steps 1-4.
8. Calculate the relative value of the surface tension and its error.
9. Compare the calculated values is with the data from the physical tables

THE REPORT

1. Purpose of the exercise performed.
2. A short theoretical introduction.
3. Tables with values of measured quantities.
4. Calculate
5. Discussion and conclusions.

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