Advanced Physical Research
Vol.3, No.1, 2021, pp.52-56

FEATURES OF TEACHING SURFACE PROPERTIES IN LIQUIDS IN UNIVERSITIES

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Abstract. In the paper a new method is developed for teaching the existing scientific and practical knowledge on the surface properties in liquids. introduction of experimental methods for determining the coefficient of surface tension to the teaching process, the methodology of using the capabilities of ICT in the visualization of surface properties has been developed. During the execution of the study: analysis of scientific and methodological literature, research of the place and content of the subject in higher education programs, methods of observation in various lessons on the subject were used.

Keywords: *Teaching process, methodology, surface properties, free volume theory, radial distribution theory.*

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Received: *05 January 2021;* ***Accepted:*** *20 February 2021;* ***Published:*** *15 April 2021.*

1. Introduction

The development and application of new research methods in various fields has led to the development of liquid physics. Recent research has yielded important results in this area by theoretical and experimental methods (Eyvazov & Ibrahimli, 2020; Safarov *et al*., 2019; Rodriguez & Olivares, 1997; Imamaliyev *et al*., 2018; Rodrigues,1997). It is very important to develop new methods for teaching these innovations in universities.Various methods are used to study and analyze the structure of liquids (Safarov *et al.*, 2019). Historically, the most universal method of obtaining initial information about the structure of liquids is X-ray diffraction. As a result of the application of this method, it was determined that the diffraction pattern of liquids, usually consisting of two and three, slightly wider and less intense annular areas, is observed.

As a result of X-ray diffraction, it was found that there is a regularity in the arrangement of particles within a small region of liquids. At low temperatures close to the crystallization temperature, this regularity is exacerbated. This shows that in the arrangement of liquid molecules at low temperatures, the so-called "close regularity" manifests itself. As a result of the interaction of liquid molecules with their neighbors, a close regularity is formed. The basis of modern molecular theory is the existence of small regions of close regularity, which are characteristic of the liquid state. In principle, each closely regularity field differs from the other in its molecular structure.

One of the fundamental properties of liquids is the coefficient of surface tension. Although a number of studies have been conducted on the temperature dependence of the surface tension coefficient in the molecular study of liquids, there is no general approach that reflects this dependence over a wide temperature range for all liquids. The coefficient of surface tension has been studied in terms of quality and quantity.

1. During the qualitative study of surface tension, it was found that the density of the liquid decreases with increasing temperature. As a result, the surface tension coefficient decreases as the surface tension substituent acting on the molecule in the subsurface layer decreases. At crisis temperature, when the densities of the liquid and the gas on it are equal, the substituent force is zero. This means that the coefficient of surface tension is zero.
2. Quantitative study of surface tension is related to the nature and temperature dependence of the subsurface layer. Quantitatively, the dependence $\sigma = \sigma(T)$ is different for different fluids.

There is the following relationship between the surface tension coefficient of liquids and other characteristic parameters:

$$\frac{d\sigma}{dT} = -B(\frac{\rho}{\mu})^{2/3}.$$

Here ρ is the density of the liquid, μ is the molecular weight, B is a constant quantity for most liquids, and is numerically defined as $B = 2{,}1 \cdot 10^4\, m^2/\ sec^2 \cdot deg.$

The temperature dependence of the coefficient of surface tension can be determined by two theoretical methods:

1. Free volume theory

During using this method, the similar properties of liquids and crystals are taken into account. According to this theory, the coefficient of surface tension is

$$\sigma = \frac{1}{S}\left[(E_Z - E) + N_S kT\, ln(\frac{V}{V_S})\right].$$

Here S is surface layer area of the liquid, E_Z is the potential energy of 1 mole of liquid bounded by the surface layer, E- is the total surface energy of N molecules, N_S is the number of molecules in the surface layer, k is the Bolsman constant.

2. The theory of radial distribution of a function

Although the free volume method allows a qualitative study of the surface tension phenomenon, it is not suitable for accurate mathematical calculations. Therefore, it is more efficient to use the theory of radial distribution of a function. The probability that two liquid particles stand at a certain distance r from each other is related to the theory of radial distribution of a function.

Knowing additive nature of the forces of intermolecular interactions and the spherical symmetry of their potentials, Fowler for the first time obtain the formula for the surface tension coefficient of pure liquids:

$$\sigma = \frac{\pi}{8}{\rho_m}^2 \int_0^\infty r^4\, U(r) g(r) dr.$$

Here U(r) is the molecular interaction potential, g(r) is the correlation function in the homogeneous liquid phase. Since both functions depend on the nature of the liquid, it is not possible to solve this equation.

Frenkel determined the temperature dependence of the surface tension coefficient on the basis of the structure and properties of liquids, the movement and interaction of liquid molecules:

$$\frac{d\sigma}{dt} = -\frac{2}{3}\sigma\alpha - \frac{\sigma\left(C_P - C_V - \frac{2}{3}R\right)}{r} - 0{,}84\left(\frac{\rho}{M}\right)^{\frac{2}{3}},$$

where $\alpha = dV/VdT$ is the coefficient of volume expansion, r is the evaporation temperature, M is the molar mass, and R is the universal gas constant ($R = 8{,}31\, C/mol \cdot K$).

As can be seen, there are different theoretical approaches to the explanation of events in fluid physics. It is important to develop new methods for teaching them. In this study, the features of the teaching of surface properties in liquids in universities were studied.

2. New variables to reduce background events

The lesson model we offer in connection with the lecture on "Surface properties in liquids" in universities is as follows:

After checking the attendance of students, the name of the topic, plan and literature are brought to the attention of students in the following order:

Topic: Surface propertis in liquids

Plan:

1. The roperties of surface tension in liquids. The surface layer and its free energy
2. Surface tension coefficient and its temperature dependence research methods
3. Wetting and non-wetting events: equilibrium condition at the boundary surface of two different liquids. Equilibrium condition on the surface of a solid-liquid boundary
4. Pressure due to surface curvature. Laplace printing for different shaped surface models.
5. Capillary properties. Juren's law for capillary tubes.

When preparing a lecture plan on the relevant topic, the directions of the topic related to the profession and specialty should be determined, scientific and theoretical materials should be collected and analyzed in accordance with the specialty, and students should be provided with the necessary professional knowledge. Otherwise, the student will take the topic lightly, think that it is not related to the profession, and refuse to listen to the topic. For example, undergraduate students majoring in Chemistry and Chemistry Teaching are taught Surface Actions in Liquids in the General Physics course. Students majoring in "Biology" and "Biology teaching" will be taught "The role of capillary action in the absorption of water by plants through absorbing wires", "Surface events during the movement of aquatic insects and reptiles on water", "Surface events in the respiratory, digestive, excretory and circulatory systems" Place and role ",“Oil and gas engineering "students should be provided with integrated knowledge on“ Surface phenomena in oil production and refining ". In this case, regardless of the specialty studied, the student will be interested in the subject.

Problem-based learning, programming and algorithms should be widely used in the main part of the lecture. Various forms of university lectures can be used to strengthen the developmental role of lectures and increase student activity.

It is more expedient to use lecture forms such as problem lecture, visual lecture, lecture-situation during teaching the relevant topic. It is known that the students got acquainted with surface phenomena in liquids in the 10th grade of secondary school. To create a problematic situation, students can be asked the following questions:

1. What is the difference between molecules on the surface of a liquid and molecules inside a liquid?
2. What do you mean by fluid surface tension?

3. Explain the physical nature of surface tension.
4. What determines the coefficient of surface tension?
5. How can we clean a drop of oil on our shirt?
6. Why does the mercury inside the breaking down thermometer can remain on the surface without collapsing?
7. Explain the physical mechanism by which aquatic insects and reptiles move without drowning.
8. What is the basis for the absorption of water by plants through absorbing wires?

After the question and answer session with the students, the lecture should be taught in a consistent and systematic manner in accordance with the plan, using information and communication technologies. The situational nature of the lectures creates emotional enthusiasm for the profession by increasing students' interest in the topic and cognitive activity.

It is necessary to form modern views on liquids during the teaching of the subject. It should be noted that there is no single theory that explains the structure of liquids. To explain the molecular mechanism of surface phenomena in liquids, it is necessary to recall the forces of intermolecular interactions. In the first chapter of the dissertation, the following steps are given in order to form the concept of surface tension in liquids:

- surface layer and molecular pressure of the surface layer;
- surface tension force and surface tension coefficient;
- free surface energy.

In the next step, the theoretical and practical research methods of the temperature dependence of the surface tension coefficient and the various equations expressing this dependence are explained. During the analysis of the processes occurring at the boundary surface of two different fluids, a physical and mathematical analysis of the surface phenomena occurring at the water-oil boundary should be carried out, the edge angle, the equilibrium condition of the droplet are noted using appropriate expressions. In the analysis of the equilibrium condition at the solid-liquid boundary, partial wetting, full wetting and non-wetting are considered separately.

During the wetting and non-wetting events, the curvature of the surface shapes is emphasized, and in order to develop students' creative thinking, different shaped surface models are shown on the electronic board through a projector. A problematic situation is created on the basis of visualization.

3. Conclusion

In the training of personnel in various specialties (scientific, scientific-pedagogical, polytechnic, etc.) in the course "General Physics" in the teaching of "Surface properties in liquids" should be integrated in accordance with the specialty. In addition to providing theoretical knowledge in lectures, students should be provided with practical knowledge in laboratory classes in order to gain more information on the relevant topic. Laboratory classes should be taught a laboratory work entitled "Determination of the coefficient of surface tension of liquids by catheter". When these are done, the following results will be obtained:

1. Providing knowledge about the place and role of the phenomenon of surface tension in nature will have a positive effect on students' mastery.

2. The development of simple home experiments on surface tension in liquids will allow theoretical knowledge to be confirmed in practice.
3. Students will increase their practical knowledge by getting acquainted with the structure and working principle of KM-8 catheter.
4. Conducting searches, collecting, analyzing and interpreting images using Internet resources will form students' initial research skills.

References

Demtroder, W. (2008). Molecular physics: Theoretical Principles and Experimental Methods, 484 p.

Eyvazov, E.A., Ibrahimli, A.B. (2020). Surface tension and heat of the surface formation of liquids. *International Journal of Modern Physics B*, 34, 2050300.

Imamaliyev, A.R., Ramazanov, M.A., Humbatov, Sh.A. (2018). Effect of ferroelectric $BaTiO_3$ particles on the threshold voltage of a smectic A liquid crystal. *Beilstein Journal of Nanotechnology*, 9, 824-828.

Rodriguez, R.F., Olivares, J.A. (1997). Parametric noise induced birefringence in nematic liquid crystals. *Revista Mexicana de Fisica*, 43, 93-107.

Rodrigues, R.F. (1997). Fluctuating hydrodynamic response in the dielectric relaxation of nematic liquid crystals. *Revista Mexicana de Fisica*, 43, 33-49.

Safarov, J., Ashurova, U., Ahmadov, B., Hassel, E. (2019). Vapor pressure of 1-butanol and diesel B0 binary fuel blends. *Journal of the Serbian Chemical Society*, 84, 599-607.