

Interfacial tension from the standpoint of continuum mechanics

VM Gotovtsev, AA Nanenkov

Currently used two approaches to the description of surface phenomena. Basis of the first of them, thermodynamic, is the assumption that the surface layer of the liquid has a certain margin of the surface energy. This energy is spent on work aimed at the formation of the interface. The transition zone between the two bulk phases in contact is a geometric surface having no thickness. On the surface there is an abrupt change in the parameters of state of matter. This view is prevalent in the theory of surface phenomena. Interphase layer is regarded as a "black box", the content of which is unknown.

In the second approach, the interphase layer is modeled by a finite layer thickness and assumes smooth change material properties through its thickness. The desire to obtain a closed system of equations of equilibrium environment in the interphase layer has led to the need to introduce the concept of disjoining pressure, acting as a compensating factor and depends on many parameters. However, the simulation environment from the standpoint of mechanics is not possible without the equation of state, the relationship between stress and strain of the object equilibrium. Given that the interfacial layer liquid - gas density of the medium varies by almost three orders of magnitude layer thickness exception state equation of the system environment of the equilibrium equations can not lead to reliable results. So far do not understand the mechanism of formation of the surface tension, and the theoretical basis of surface phenomena remain at the time of the Young and Laplace.

The authors propose a new approach to the description of surface phenomena, which is based on the theory of van der Waals forces. This theory is based on the description of the intermolecular interaction between elements of the environment in both the liquid and vapor state. The equation of state of the environment, establishing the relationship between pressure and density is called the van der Waals forces, and the pressure dependence of the specific volume of the medium at a constant temperature isotherm is called van der Waals forces. According to existing ideas a significant part of the isotherm plots describes the unstable state of matter that can exist under special conditions for a short time. It should be noted that such representations are valid in respect of bulk phase medium in which state parameters are the same at each point of the volume and pressure of Van der Waals forces is meant the external ambient pressure.

Quite a different picture emerges when considering the interfacial layers. Here, on the small thickness of the layer is a global change of state parameters of the medium, and the external pressure of Van der Waals forces with a high degree of accuracy can be made zero. In the equation of van der Waals pressure present in two forms: attraction and repulsion. At zero external pressure knowledge-tion of these pressures

should be equal. Next, you need to note the fundamental difference of these pressures - they form the force fields of different physical nature. Pressure due to the effect of gravity when the forces of intermolecular attraction, having the character of body forces and forming a vector force field. Repulsive forces belong to the class of surface forces with the tensor force in field. It follows that the algebraic summation of the pressure of attraction and repulsion, which is valid for the bulk phases, can not be used to describe the interfacial layer.

In accordance with this tensor interfacial stresses in the equations of equilibrium represented by the collection of ball and deviatoric parts. Ball of the pressure tensor formed repulsive forces, ie surface forces, and the deviator - volume forces of intermolecular attraction. Based on the fact that the sum of the principal stress deviator is zero resultant force of attraction, oriented perpendicular to the surface layer gives rise to stresses acting in the plane of the interfacial layer. It is these stresses form the surface tension of the liquid.

Thus interfacial layer isotherm Van der Waals correspondence is not one point as in the case of the bulk phase and a portion of the isotherm in which there may be significant changes in fluid density. This effect can be explained from the standpoint of the theory of the structure of liquids hole developed Frenkel. The main point of the theory is the assumption that real-valued liquid is a dispersion of vapor bubbles in the liquid. In depending on the concentration of bubbles the density of the medium may vary the density of the liquid itself to the density of saturated steam.

Unfortunately the volume does not permit detailed presentation of the extended position. More detailed information on them can be found in the materials of the international-term scientific conference "Mathematical Methods in Engineering and Technology - MMTT -27", held on 3 - 5 June 2014 on the basis of Tambov Tambov State Technical University.