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EQUIVALENCE OF ENERGY AND MASS OF SUBSTENCES

Abstract. In this article the transfer of thermal energy is considered by elementary particles- "theplotrons". The equation between the mass and energy indicates their equivalence. This statement means that the mass does not become energy, and energy is a property of matter that characterizes its movement. The temperature of system is determined by "pulsation" of the " teplotron ."

Keywords: energy, mass, heat, "teplotron", temperature, "chemical individual", Gibbs's equation.

Introduction. The study of the forms of transfer of thermal energy between material objects is one of the important tasks of natural science. Historically, to explain the transfer of thermal energy, German chemists I.I. Beher and G. E. Stahl, the creators of "phlogiston theory" [1], believed that the carriers of heat are the smallest particles - "corpuscles of phlogiston." In their opinion, the "corpuscles of phlogiston" can not be detected materially, and air is an object that contributes to the release of particles of "phlogiston" from various substances and to absorb them. However, most scientists advanced the notion of heat as a movement of internal parts of bodies with a refutation of "phlogiston theory" [2]. Currently, there are various types of heat transfer, the main types of which are [3]:

- convective heat exchange between liquid or gas flows and the surface of a solid body;
- heat transfer from a hot medium (liquid, gas or solid) to the cold part of the system through the dividing partitions;
- joint heat transfer by radiation (radiant) and convection.

In all cases, the transfer of thermal energy from one material part of the system to another, differing in temperature, before the onset of thermodynamic equilibrium. There are many points of view on the mechanism of energy exchange when contacting between material objects [3-7]. And the first person who realized that the allocation of heat during the movements of contacting 0bodies is the direct result of bringing mechanical energy to the rubbing parts was B. Thompson known as the graph of Rumford [7]. But how does the transformation of mechanical energy into heat occur during friction? There is still no exhaustive answer to this question. And despite the rich accumulated material on heat, as a form of energy transfer, the mechanism of its transmission and the physical meaning of temperature-the quantitative evaluation of the degree of heating of the system-remains unclear. In this paper, an attempt was made to discover the mechanism of heat transfer between material objects based on the molecular-kinetic, thermodynamic, and quantum-mechanical theory and the quantitative criterion of the thermal state-temperature.

Discussion. Energy is an inalienable property of matter, expressing its movement and constituent elements from microscopic to macroscopic formation. Massive bodies are characterized by potential and kinetic energies, which ensure the fulfillment of mechanical work. Similarly, the elementary particles entering the microstructure of the "chemical individual" [8] in the set represent the internal energy, the change of which is transmitted in the form of heat, light, work, etc. in the system of material objects under consideration. In this case, the material characteristics of micro- and macroobjects of the surrounding world, is characterized by a rest mass or mass in motion. In [9] there is a correlation between "energy", "momentum" and mass, which are manifested in nature in two qualitatively different ways, which gives grounds for subdividing it into two varieties:

- inert mass, which characterizes the inertness of bodies in the aggregate of constituent elements of a given kind of matter under given conditions;

- the gravitational mass shows the interaction of the body with the external gravity fields, which is the basis for measuring the mass by weighing.

Despite of this, it should be noted that the material object exists in the given system with its constituent elements regardless of the measure being measured and represents the nature of this individual. Indeed, with the generally accepted choice of units, the gravitational and inertial masses of the body are equal to each other [10]. In this connection, the mass of the body expresses a physical quantity that is a measure of the inert properties of matter and at the same time a measure of its gravitational properties, i.e. it is a question of the same individual of a material object. In turn, a conceptual expression "energy" is introduced - for describing quantitative and qualitative of movement of material object with its corresponding mass ,i.e. the movement is the characteristic property of matter. The well-known equation of the interrelation between energy and mass in the form of kinetic **($\varepsilon = mv^2/2$),** potential ($\varepsilon = mgh$) energies , momentum (mv) and $\varepsilon = mc^2$ and express their equivalence. In addition, the change in the energy characteristics of material objects as a result of the physicochemical process for open systems is described by the fundamental Gibbs's equation:

$$dU = TdS - pdV + \Sigma\mu_i dn_i$$

$$dH = TdS + Vdp + \Sigma\mu_i dn_i$$

$$dA = - pdV - SdT + \Sigma\mu_i dn_i$$

$$dG = VdP - SdT + \Sigma\mu_i dn_i$$

The state functions ***U, H, A, G*** and ***S*** express energy characteristics that directly relate to a certain type and number of material objects constituting the system. And on the right side of the equation, the term - $\Sigma\mu_i dn_i$ shows the change in the energy characteristic of an open system due to a change in the amount of matter (particles, ions, etc.). According to the properties of the total differential of functions, their partial derivatives with respect to the i-th amount of a material object, with the constancy of other variables, express the corresponding types of potentials (thermochemical, electrochemical, etc.), the sum of which represents the chemical potential of the system. Consequently, the partial derivative with respect to the number of elementary particles related to thermal phenomena, with the constancy of other parameters of the system, expresses the chemical potential (μi) of thermal particles, ie:

$$\mu_i = (\partial U / \partial ni)_{S, V, nj} = (\partial H / \partial ni)_{S, p, nj} = (\partial A / \partial ni)_{T, V, nj} = (\partial G / \partial ni)_{T, p, nj}$$

It follows from these expressions that the thermal energy is transmitted by an elementary particle with a certain mass and a "thermochemical" potential μ_i. It should be noted that only in the process manifest forms of energy transfer in the form of heat, light, electricity, work, etc. In this connection, it is quite difficult to study phenomena, determine the rest masses of energy carriers, which end with the termination of the process. The question arises, in what form are the carriers of heat and light in the material object? However, this issue is beyond the scope of this article and on the accumulation of elementary energy carriers will be reported in the following publications.

In [11] we used classical laws of thermodynamics and molecular-kinetic theories to determine the mass of elementary heat carriers based on thermo-chemical data of hydrogen combustion with formation of water. The heat of combustion of hydrogen is **285.8 kJ/mol** and calculations show that out of this amount **114.4 kJ/mol** of heat dissipates into the environment. According to the equation $\varepsilon = mc^2$, with a loss of **114.4 kJ** of heat from the system, a loss of **$12.7 \cdot 10^{-13}$ kg** of the mass of the "elementary particles" of the heat carriers is equivalent. The calculations on the calculation of the mass of elementary heat carriers have shown that this value is **$5.15 \cdot 10^{-36}$ kg**, and according to the wave optics data **$3.87 \cdot 10^{-36}$ kg** [11-14]. These heat carriers are called "teplotrons". The values given are determined by two different methods ($5.15 \cdot 10^{-36}$ kg and $3.87 \cdot 10^{-36}$ kg), which shows quite good agreement in the absence of purposeful experimental data. However, in [11] we showed inconsistencies in the energy values of the system of thermal chaotic motion of water molecules calculated for kinetic energy at 3173 K (**39.54kJ**) and experimentally determined thermal energy from thermochemical data (**285.8kJ)** at the same temperature (this temperature corresponds to the maximum combustion temperature of hydrogen in oxygen). The large difference in the values of the heats determined by two different traditional methods means that in addition to the thermal motions of the molecules, one should take into account the contribution to the kinetic energy of the heat carriers of the "teplotrons". Under thermal equilibrium conditions of the system, the total value of the contributions of the kinetic energy of the elementary particles of the heat carriers ($\Sigma x_i kT$) should equal the energy of the quanta of thermal radiation ($h\nu$), ie for the same particle the following equality holds:

$$\Sigma\, x_i\, kT = h\nu.$$

In contrast to the frequencies (ν) in M. Planck's equations, $\varepsilon = h\nu$, in the proposed article "ν" refers to the frequency of "pulsations" of elementary particles proposed in [15]. To determine the number Σx_i, we use the spectroscopic data of IR radiation. It follows from the above formula that the temperature of the system is proportional to the frequency of the "pulsations" of the elementary particle,

$$T = h\nu / \Sigma x_i k = 6{,}6261 \cdot 10^{-34} \nu / (\Sigma x_i \cdot 1{,}3806 \cdot 10^{-23}) = 4{,}7994 \cdot 10^{-11} \cdot \nu / \Sigma x_i$$

where ν is the frequency of the "pulsations" of the elementary particle, c-1;

The total kinetic energy of the thermal motion of an elementary particle:

$$\Sigma x_i kT = 5kT.$$

Hence, for a system in thermal equilibrium with the surrounding medium with thermal radiation, it is valid:

$$5\,kT = h\nu.$$

The left-hand side of the equation expresses the total contribution of the kinetic energy of the motion of the elementary particle to the thermal particle, and the right-hand side characterizes the thermal radiation (Planck's equation). We determine the mass of the particle with allowance for the Einstein equation from the formula $\varepsilon = mc^2$ [16]:

$$\mathbf{m = 2.189 \cdot 10^{-19} / (3 \cdot 10^{8})\ 2 = 2.432 \cdot 10^{-36}\ kg}$$

Consequently, the temperature of the system depends on the frequency of pulsations of elementary particles responsible for the thermal state, i.e.:

$$T = h\nu / \Sigma x_i k = 0.959 \cdot 10^{-11} \cdot \nu,$$

where $h / \Sigma x_i \cdot k = 0{,}959 \cdot 10^{-11} K{\cdot}s$ is the temperature constant of the elementary particle - the heat carrier of "teplotrons". From here we can draw a conclusion: the thermal state of the system is determined by the frequency of pulsations of elementary particles of heat carriers - "teplotrons", proportional to temperature, and the arrangement of the structural elements of the "chemical individual" is characterized by the entropy factor. The thermal state of the system is characterized by the formation of "combinations of heat sources" with the structural elements of the "chemical individual". The free concentration of "teplotrons" determines the temperature of the system.

Conclusion. The new fundamental concepts - heat transfer by "teplotrons", the possibility creating "combinations" between elementary particles, "pulsation" of micro-objects are proposed. The development of these fundamental provisions for their practical use promises a breakthrough in technologies aimed at creating new materials, saving energy and protecting the environment.

The transfer of heat by "teplotrons" indicates the equivalence of energy and mass. Energy is the characteristic value of matter and is determined by it. This statement means that the mass does not turn into energy and vice versa. If there was no material world, then there would be no question of energy. On the basis of the universal law of conservation and transformation of matter and energy, we can confidently assume that the named forms of energy transfer realized by "elementary particles", when interacting with material objects, form other kinds or combinations of the material world.

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Резюме

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ЗАТ МАССАСЫ МЕН ЭНЕРГИЯ ЭКВИВАЛЕНТТІЛІГІ

Қарастырылып отырған мақалада жылу энергиясының элемантар «жылу тасымалдағыш» бөлшектер «теплотрондар» арқылы тасымалданатындығы баяндалады. Масса және энергия арасындағы байланысты өрнектейтін теңдеу тек олардың эквиаленттілігін сипаттайды, яғни масса мен энергия өзара бір-біріне түрлене алмайды.Энергия материалдық дүниеліктің қозғалысын сипаттайтын шама. Жүйе температурасы «теплотрондардың» пішін жиілігі өзгерісімен (пульсация) анықталынады.

Түйін сөздер: энергия, масса, жылу, «теплотрон», температура, «химиялық индивид», Гиббс энергиясы.

Резюме

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ЭКВИВАЛЕНТНОСТЬ МАССЫ И ЭНЕРГИИ ВЕЩЕСТВ

Рассматривается передача тепловой энергии элементарными частицами носителями теплоты – «теплотронами». Уравнение, показывающее взаимосвязь массы и энергии, указывает на их эквивалентность, но не равенство массы и энергии. Энергия является свойством материи, характеризующей его движение и означает невозможность взаимного превращения. Температура системы определяется «пульсацией» «теплотронов».

Ключевые слова: энергия, масса, теплота, «теплотрон», температура, «химический индивид», уравнение Гиббса.