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THE NATURE AND MASS OF ELEMENTARY PARTICLES OF HEAT CARRIERS

BT Utelbayev[1], EN Suleimenov[2], AB Utelbayeva[3]
[1]Dr.Sci.(Chemistry), Professor Kazakh-British Technical University.
[2]Dr.Sci.(Tech.), Deputy Director of the Laboratory "Advanced Materials and Technologies", Kazakh-British Technical University,
[3]Dr.Sci.(Chemistry), Associate Professor, South Kazakhstan State University named after M. Auezov.

***Abstract-* One form of energy transmission is heat transfer. So far, remain debatable issues related to the mechanism of heat transfer from one object to another. The article proposes to consider that the transfer of heat between the material objects made by elementary particles - "teplotron". On the basis of the classical equations of thermodynamics and molecular-kinetic theory calculated the speed and mass of these particles - carriers of heat.**

Keywords: energy, microstructure, “chemical individual”, heat, "teplotron", photon.

I. INTRODUCTION

The transfer of heat previously described in the "phlogiston theory" which even allowed to predict the results of the process, if the initial conditions are known [1]. It is now argued that the "phlogiston theory" was finished [2], but it is believed in [3] to describe the flow of energy. This theory in a hidden form is widely used in practice to explain the heat transfer, for example, by using the law of Fourier [2]. In the Fourier equations, "heat flux" accepted as a form of movement. However, carriers of heat involved in the heat flux remains out of discussing. This leads to different interpretations of heat transfer mechanism. For example, in [3] noted that at using the Fourier's law essentially retained the terminology, units of heat values and the definitions of theory "phlogyston" and offered to give up of these expressions. However, the concept of flow, which characterizes a certain kind of movement of material objects, in particular related to the heat, requires clarification the elementary participants of this process. This article is devoted to clarify the nature of the heat carriers.

II. DISCUSSION

According to generally accepted definitions in the scientific literature, the heat is a form of transfer internal energy from the hotter parts of the body to the less heated parts, which leads to the equalization of the system temperature. The change of state a system in the energy processes in thermodynamics are described by Gibbs's fundamental equations [4,5,6]. For an infinitesimal change in internal energy (dU) the equation for open system is as follows:

$$dU = TdS - pdV + \Sigma \mu_i dn_i \qquad (1)$$

where TdS- infinitesimal amount of heat, pdV - the work of expansion , $\Sigma \mu_i dn_i$ - shows the change in the energy state of the system by changing the amount of i-substance(particle) at the appropriate value of its chemical potential μ_i. The expression $\mu_i dn_i$ includes parameter μ_i, called "chemical potential" that individualizes i-th particle or substance, taking into account changes in their infinitesimal amounts dn_i. From thermodynamics it is known that the functions of the U, H, A and G are indicative and partial derivatives define other specific thermodynamic quantity that characterizes the property of the system. Infinitesimal change in the number of particles undergoing thermal energy in this case, when the other parameters constant, has to determine the chemical potential of the i-particles relating to heat:

$$\mu_i = (\partial U/\partial n_i)_{S,V,nj} = (\partial H/\partial n_i)_{S,p,nj} = (\partial A/\partial n_i)_{T,V,nj} = (\partial G/\partial n_i)_{T,p,nj} \qquad (2)$$

From the above partial derivatives implies that the chemical potential energy expresses the number of units of a particular characteristic of the i-th material object (heat particles) at the constant other parameters of the system. The fundamental Gibbs's equations of function of the state U, H, A, G and S express the energy characteristics that are directly attributable to a certain amount of material objects.. In [7], at considering the connection between the mass and energy of the reactants in the reacting system was marked change in mass of a closed system by the heat dissipation to the environment. That is, in fact, the author [7] states that the heat has a material nature.

In this regard, to determine the true position, consider the thermodynamic process of hydrogen combustion, which is allocated a certain amount of heat to form water. The molar heat of formation of water $\Delta H_f^0(H_2O_{liq})$ to quantify the value equal to the heat of combustion $\Delta H_c^0(H_2)$ of one mole of hydrogen where thermochemical equation looks the following way:

$$H_2 + 0{,}5O_2 \rightarrow H_2O \quad \Delta H_c^0(H_2) = \Delta H_f^0(H_2O_{liq}) = -285.8 kJ/mol \qquad (3)$$

We assume that the reaction takes place under standard conditions: $T = 298K$ and $P = 1.05 \cdot 10^5 Pa$ in a closed system, i.e. molecules of reactants do not exchange with the environment . In other words, it must be strictly adhered to the law of conservation of mass and energy in the system under study. We accept the value of specific heat liquid water

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$C_p(H_2O_{liq})$ = ***4.218kJ/kg;*** specific heat water vapour $C_p(H_2O_g)=2.02kJ/kg$; heat of vaporization of water ***2260.0kJ / kg*** [8]. According to [9] at a hydrogen combustion temperature in oxygen reaches 3173K or 2800^{0}C. Assuming that the heat emitted during the combustion of hydrogen is equal to the heat of formation of water, make up the thermal balance. After making the reactions resulting steam with a temperature of 3173K is cooled to 373 K, giving to the environment some heat, it condenses and subsequently cooled to 298K. In carrying out this process reverse at isobaric condition the water is heated from 298K to 373 K (ΔH^0_1 heating), boils at 373 K and convert the liquid phase to steam (ΔH^0 evaporation), then the steam is heated from 373 K temperature to 3173K (ΔH^0_2 heating). As a result, is changed internal energy of water and performed the work of expansion (W_{exp}). In this case the heat balance equation becomes:

$$\Delta H_c^0(H_2) = \Delta H^0_1 + \Delta H^0 \text{(evaporation)} + \Delta H^0_2 + W(\text{exp}) \quad (4)$$

For each stage, taking into account the specific heats of water and process temperature equation (4) is written in the following form:

$$\Delta H_c^0(H_2)=C_p(H_2O_l)(T_b-298)+\Delta H^0(exp)+C_p(H_2O_g)(T_{end}-T_b)+P\Delta V+T\Delta S \quad (5)$$

Water expansion work W_{exp} is equal $P\Delta V$ and calculate using the equation for one mole steam through $R\ (T_2 - T_1)$ in the temperature range from373 K up 3173K. In this case, the equation is as follows:

$$\Delta H_c^0(H_2) = C_p(H_2O_{liq})(373\text{-}298)+\Delta H^0_{evap})+C_p(H_2O_g)(3173\text{-}373)+R(T_2-T_1) +T\Delta S \quad \text{……..} (6)$$

Here, the amount of $C_p(H_2O_{liq})(373 - 298)+\Delta H^0(evap)+C_p(H_2O_g)(3173\text{-}373)$ is the change in internal energy (ΔU), ie.:

$$\Delta U = 4.21\cdot 18\cdot(373\text{-}298) + 2260{,}0\cdot 18 + 2.02\cdot 18\cdot(3173\text{-}373) = 148.16\cdot 10^3 J. \quad \text{………}(7)$$

At the work expansion of water vapor ($P\Delta V$) the energy is expended:

$$P\Delta V = R\ (T_2\text{-}T_1) = 8{,}314 \cdot 1 \cdot (3173\text{-}373) = 23{,}28 \cdot 10^3 J. \quad (8)$$

Substituting numerical values into the equation (6) based on one mole of water and we obtain:

$$285.8 \cdot 10^3 = 148.16 \cdot 10^3 + 23.28\cdot 10^3 + T\Delta S \quad (9)$$

There is $T\Delta S$ amount of heat dissipated into the environment. It will be calculated from the equation (9) as the scattered of heat- $T\Delta S$:

$$T\Delta S = (285.8 - 171.4) \cdot 10^3 = 114.4\cdot 10^3 J \quad (10)$$

The heat generated by the combustion of hydrogen (285.8 · 10^{3}J) would have to be spent to carry out the work of expansion and changes the internal energy of the system. However, it spent 171.4·10^{3}J of heat and 114.4·10^{3}J is dissipated heat which the share is equal:

$$114.4\cdot 10^3 : 285.8\cdot 10^3 = 0.40 \quad (11)$$

That is, the proportion of 0.40 dissipates heat into the environment. In a closed system under consideration, where 114.4 ·10^3 J of energy moves into the environment. Now we calculate the energy of moles of water vapor at a temperature of 3173K, based on the provisions of the molecular-kinetic theory [10]:

$$E_{3173}=(3/2)k\cdot N\cdot T=1.5\cdot 1.38\cdot 10^{-23}\cdot 6.02\cdot 10^{23}\cdot 3173=39.54\cdot 10^3 J . \quad (12)$$

Speed of movement of water vapor molecules v corresponding to this value of the energy we determined from $E = (mv^2 / 2) \cdot N$. Hence:

$$v^2 = 2\cdot E/(m\cdot N); \quad v^2 = 4.39\cdot 10^6; \quad v = 2.09\cdot 10^3 m/s \quad (13)$$

The speed of movement of water vapor molecules at the energy corresponding to the heat of formation of water vapor is defined similarly:

$$v^2=2\cdot E/(m\cdot N);$$

$$v^2=2\cdot 241.8\cdot 10^3/(18\cdot 1.66\cdot 10^{-27}\cdot 6{,}02\cdot 10^{23}); \quad v = 5.18\cdot 10^3 m/s. \quad (14)$$

The calculation shows that the kinetic velocity of water vapor molecules changes 2.48 times (from 2,09 ·10^{3}m/s to 5.18 · 10^{3}m/s) when the energy changes 7.2 times (from 39.54 · 10^{3}J to 285.8 · 10^{3}J). These figures testify about the secondary role of the movement of water vapor molecules in the transfer of heat and gives an indication of the reality of some "heat particles" - a carrier of heat. According to the data of the thermodynamic energy for the mole of water formation is 285.8·10^{3}J and from it 114,4·10^3 J heat is dissipated into the environment. At this temperature (3173K) the calculated kinetic energy related to one mole of water vapor is 39.54·10^{3}J. From the difference of the calculated values it is obvious that by using classical molecular-kinetic equations, there is some unaccounted component of the energy balance. Consequently, when on system is impacted with energy there occur a change, and heat transfer is realized by "thermal particles" - similar as the carriers of light - optical photons. In other words, legitimate to raise the question of the existence of the elementary carriers of heat that must be taken into account in the analysis of physical - chemical processes in the development of innovative technologies in various fields of technology. Since the existence of elementary particles - carriers of heat is not included in the classical equations of molecular-kinetic theory, this makes it impossible to explain the many abnormal phenomena in nature and technology.

According to current views, the heat transfer is carried out in a vacuum thermal radiation source, which refers to infrared [11,12,13]. In this respect, the thermal radiation is a process " spread of internal energy of the body in the space by emitting the energy" as electromagnetic waves in a vacuum where they are distributed at a certain speed. Without prejudice the principles of wave optics and using its well-known equations, characteristic values of the infrared waves, which are listed in the reference material [13] we try to determine the velocity of the carrier heat. For the near-infrared range in a vacuum: the energy (E) to 1.7 eV; the temperature (T) to 4000K; frequency (ν) to 4 • 10^{14} Hz and the wavelength (λ) about 730 nm, we calculate the velocity of elementary particle carrier of heat by following equation:

$$\nu = \overline{\upsilon} / \lambda \qquad (15)$$

Hence, the speed of an elementary particle that carries the heat is:

$$\overline{\upsilon} = \lambda \cdot \nu = 4 \cdot 10^{14} \cdot 730 \cdot 10^{-9} = \mathbf{2{,}92 \cdot 10^{8}} \text{ m / s} \qquad (15')$$

Similarly, for the mid-range with ***E ≈ 0.25 eV; T up to 600*** K; ν ≈ 6 • 10^{13} Hz and with λ≈ 5 • 10^{-6} m calculated the speed of an elementary particle that carries the heat is:

$$\overline{\upsilon} = 6 \cdot 10^{13} \cdot 5 \cdot 10^{-6} = \mathbf{3{,}0 \cdot 10^{8}} \text{ m / s} \qquad (16)$$

Using the values of the calculated velocities "thermal particles" of infrared radiation, the calculation of the mass dissipated into the environment in the form of heat (***TΔS***) carry on the Einstein equation relating the mathematical equivalence of energy and mass:

$$m = E/c^2 = T\Delta S/c^2 = 114{,}4 \cdot 10^3 / (3 \cdot 10^8)^2 = 12{,}711 \cdot 10^{-13} \text{kg} \qquad (17)$$

For the combustion of hydrogen is calculated based on the heat of formation of one mole of water, and 40% of heat is dissipated into the environment, assume the number of elementary particles is equal to 0,40 · 6,02 · 1023 = 2,408 · 10^{23}. Hence we calculate the mass of elementary particles which is approximately equal to:

$$m(particle) = 12{,}711 \cdot 10^{-13} : 2{,}408 \cdot 10^{23} = 5{,}279 \cdot 10^{-36} \text{kg} \qquad (18)$$

For the process in the combustion of hydrogen from $285.8 \cdot 10^3$J of heat is dissipated $114.4 \cdot 10^3$J into the environment. According to reference data [8] ***1 kg*** corresponds to $\mathbf{8.98755 \cdot 10^{16} J}$ of heat. To determine the mass (***m***) of "heat carrier» carried away with $\mathbf{114.4 \cdot 10^3 J}$ of heat we use following relation:

$$m = 114{,}4 \cdot 10^3 / 8.98755 \cdot 10^{16} = 12.728 \cdot 10^{-13} \text{ kg} \qquad (19)$$

For one mole of water the mass of "heating particles" is:

$$m = 285.8 \cdot 10^3 / 8.98755 \cdot 10^{16} = 31.799 \cdot 10^{-13} \text{ kg} \qquad (20)$$

The mole is numerically equal to $\mathbf{6.022 \cdot 10^{23}}$ structural units, and calculated the mass of a single structure of "heat particle":

$$m\ (particle) = 31.799 \cdot 10^{-13} / 6.022 \cdot 10^{23} = 5.280 \cdot 10^{-36} \text{ kg} \qquad (21)$$

Comparison the mass value of transporter of heat - "teplotron" calculated by two different methods show a perfect match($\mathbf{5.280 \cdot 10^{-36}}$ ***kg and*** $\mathbf{5.279 \cdot 10^{-36}}$ ***kg***), even in the absence of targeted experiments. An elementary calculation shows that the heat transfer mechanism can easily explain the existence of elementary particles - carriers of heat, which in [14,15,16,17,18] conditionally named "teplotron". From these data it follows a logical question the location of "teplotron" in the composition of the substance. However, "reserves the amount of heat" in the matter can not be taken into account in an explicit form and this fact put the task to find out the nature of heat transfer and heat carrier between material objects.

According to [19,20,21,22] the motion of electrons in the field of nuclei at steady-state condition causes a magnetic field. Since we are considering moving electron in interaction with nuclei, the acting forces is called electromagnetic forces. According to Faraday, if each charge creates a field, therefore it is natural to assume the presence of electric and magnetic fields. According to modern concepts [23], "electromagnetic field" - is a special form of matter, through which cause the interaction of charged particles.

In [24], we proposed some conceptual expression "chemical individual", which is a basic unit, responsible for the formation of elementary particles creating electromagnetic field [25]. From this point of view, the motion of the electron around the nucleus is a process and as result of the process is carried out energy transfer. Therefore, at stationary-state "elementary particles" are produced in the microstructure of "chemical individual", and are in dynamic equilibrium with the elementary particles of the environment corresponding to the given energy state. In turn, the energy is a conceptual expression describing qualitatively and quantitatively the motion of particles (matter) and the transition from one type of motion into another. Thus, manifestation of energy it is the movement of elementary discrete particles or energy carriers have the material nature. A good example is the well-known phenomenon of mass defect ***Δm***- the difference between the total mass of the nucleons in a free state and the mass of the nucleus [10], accompanied by the release of huge amounts of energy. Similarly, when chemical reactions are taken there occur a redistribution of valence electrons between the nuclei of the original and the newly formed compounds and are released (absorbed) energy equivalent to the mass of "teplotron" and other. Thus, "teplotron" or other elementary carriers of energy produced only at the process, and "reserve of heat " in the system does not explicitly show up. Released number of "teplotron" or other elementary particles are absorbed by the environment [17,26]. It should be noted that by purposeful movement of "particles" with the appropriate hardware design or technical solutions can receive various kinds of works. Such processes include chemical, biological, electrical, mechanical and other kinds of work. For all these works moving(redistribution) electrons is a characteristic and is noted by M.Faradey in [27], where the work is simultaneously accompanied by other physical and chemical manifestations. These symptoms are the result of collective motion of elementary particles - photons, "teplotrons", electrons and others, where the character of their movement determines the nature of a phenomenon and explains the mechanism of energy transfer from one material object to another. That is, from this point of view can be explained electrification facilities, electromagnetic displays, lighting, sound and others. All of these changes depend on the external force, which change the nature of particle movement between the nuclei in the "chemical individual" [17.26, 28].

CONCLUSION

Energy is an inherent property of matter, and the internal energy characterizes the set of movement of microscopic elements of a macroscopic object. Different elementary particles are responsible for transfer of the various forms of energy. The change of internal energy reflected as the macroscopic manifestations in the form of heat, light, electricity, etc., where transmission realized by elementary particles of a material object. It should be noted that the discrete transmission mechanism of heat by elementary particles is not contrary to the fundamental provisions of the quantum physics of heat transfer. The acceptance of discrete elementary particles such as "a teplotron" gives the opportunity to spend a full analogy between the effects of various forms of energy on the physical - chemical processes.

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