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TERMS, LETTER SYMBOLS AND DEFINITIONS ON HEAT AND MASS TRANSFER USED IN THE SOVIET UNION

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Аннотация—В статье даётся краткий исторический обзор развития науки о тепло-и массообмене в работах русских учёных и приводятся специфические термины, обозначения и определения, возникшие при этом, но не получившие ещё щирокого распространения.

THE availability of generally accepted terms and letter symbols in a given scientific discipline contributes to a wide international contact of scientists working in that field of science.

The science of heat and mass transfer is one of the youngest: it has arisen on the basis of separate disciplines during the last ten years, and up to now no generally accepted terminology has yet been worked out.

It is quite impossible for one person or even for a group of scientists of one country to create uniform international terminology in such a developed and complicated scientific discipline as heat and mass transfer.

This work must be fulfilled by collective labour of scientists of a number of countries. In this paper the author seeks to solve a more modest problem, i.e. to acquaint foreign specialists with some specific terms for heat and mass transfer used in the Soviet literature. This work may serve as a step in creating the uniform international terminology for heat and mass transfer.

For better understanding of specific terms on heat and mass transfer used in the Soviet Union we preliminarily include a short historical review of the development of this field of science in our country.

In Russia the development of the science of heat and mass transfer is bound up with the name of the greatest Russian scientist, Academician Mikhail Vasilievich Lomonosov [19] who in 1744–1747 was the first to express his opinion and to give the fundamentals of the mechanical theory of heat, the concept of absolute temperature zero as well as the main bases of the first and second laws of thermodynamics in his work *Reflection on the Cause of Heat and Cold.*

Parallel with M. V. Lomonosov, heat transfer problems were considered by Academician G. V. Rikhman who discovered the effect of a wet thermometer, determined the velocity of both water evaporation and cooling and solved a number of other heat transfer problems [34].

The Russian scientists B. B. Golizyn (1892) [3], S. Y. Tereshin (1898) [39] and V. A. Mikhelson (1882) [27] were engaged in studying radiative heat transfer. They grounded the Stefan law and verified it experimentally. The Russian scientist V. A. Ulyanov (1899) [46] proved the Lambert law theoretically. The noted physicists F. F. Petrushevsky (1874) [29], B. V. Stankevich (1891) [36] and R. E. Lents (1869) [18] were engaged in determining heat conductivity of various bodies.

The scientists S. Y. Tereshin (1898) [40] and N. A. Gezekhus (1876) [1] studied free convection and evaporation of a liquid in a spheroidal state. The priority in considering electrical heat analogy (1897) also belongs to Gezekhus.

Vast investigations in different heat transfer problems were carried out by Russian scientists in the thirties and following years of the twentieth century. Among the main investigations of this period we should mark the works on the development in the fundamentals of the similarity theory of heat and hydrodynamic processes [7, 4, 28, 9, 50, 30]; on investigations into heat transfer on the basis of the similarity theory at changing aggregation state of a heat agent [13–16, 12, 37]; on radiative heat transfer in furnace chambers of vapour boilers and other devices [5, 41–45, 38, 10]; on investigations into heat conductivity in non-stationary processes [21, 22, 3, 11]; on boundary layer theory [8, 20, 6]; on heat transfer investigations with chemical reactions [33, 49, 48]; on investigations in a drying process [23, 24, 17, 2, 47].

Russian scientists played an important role in developing the mass transfer theory and in creating the uniform heat and mass theory (A. V. Luikov) based on thermodynamics of irreversible processes and taking into account interrelation of heat and substance transfer processes [25, 26].

The development of fundamentally new problems on the heat and mass transfer theory carried out by Russian scientists in the Soviet Union gave a number of new specific terms and definitions [51], in addition to the already existing ones, which won recognition from scientists of other countries.

The table of main specific terms, letter symbols and definitions of heat and mass transfer used in the Soviet literature but not used on a large scale is given on this and the following pages. The table of terms mentioned is given in the following order: the number of the term; the term accepted for a given concept on heat and mass transfer; the letter symbol for the term; and the definition of the term with its mathematical formulation.

No.	Term	Letter symbol	Definition of the term
1.	Heat transfer at contact		Heat transfer between solid and liquid (gaseous) phases, being in contact, caused by a simultaneous action of heat conduction and convection.
2.	Heat transfer coefficient	α	Proportionality coefficient in the Newton formula characterizing heat transfer intensity at contact and numerically equal to the relation of a specific heat flow through an interface of two contacting phases and the temperature difference unit between the latter.
3.	Heat exchanger with intermediate heat transfer agent		Heat exchanger with a stationary temperature regime where heat transfer from a heating agent to a heated one is carried out by continuously circulating intermediate heat agent, being in immediate contact with working heat agents.
4.	Power efficiency coefficient of a heat exchanger	η_e	Coefficient which characterizes the use of the heat potential in a heat exchanger included in the scheme of a heat power device. It is numerically equal to the relation between the workability of heat gained by a heated agent and the workability of heat lost by a heating agent.
5.	Entropy efficiency of heat exchanger	η_{ent}	Coefficient characterizing the use of a heat potential both in combined schemes with heat use and in industrial heat exchangers. It is numerically equal to the ratio of the absolute value of entropy change of a heating agent to entropy change of a heated agent.
6.	Substance transfer potential (heat, etc.)	Π	Generalized driving force of a transfer process of a given substance numerically equal to the derivative of the corresponding characteristic function by a generalized co-ordinate, determining a quantitative measure of a transferred substance in a process.
7.	Mass transfer potential	θ	Generalized driving force of the mass transfer process equal to the derivative by the substance mass of the correspondingly chosen characteristic function depending on thermomechanical conditions of transfer.
8.	Mass transfer coefficient	α_m	Coefficient characterizing intensity of a mass transfer process at the interface, numerically equal to the ratio of the density of a substance mass flow to the difference of potentials of mass transfer at the interface.

No.	Term	Letter symbol	Definition of the term
9.	Mass content	$\mathscr{M}$	Mass quantity of an absorbed substance, in a capillary-porous body.
10.	Specific mass content	U_m	Ratio of mass content of an absorbed substance to the mass absolutely dry substance of a body itself.
11.	Specific mass capacity	C_m	Derivative of mass content by a potential of mass transfer.
12.	Coefficient of mass conduction	λ_m	Coefficient characterizes the ability of a body to conduct a bound substance. It is numerically equal to the ratio of a specific flow of the bound substance to the gradient of potentials of its transfer.
13.	Coefficient of potential diffusivity of mass transfer	a_m	Physical parameter characterizing the rate of mass content levelling in a body in a non-stationary process, numerically equal to the ratio of the mass conduction coefficient to specific volume mass capacity.
14.	Thermogradient coefficient	δ	Coefficient characterizes the transfer of a bound substance caused by a heat driving force. It is numerically equal to the ratio of drops of moisture content to temperature in a stationary state without heat transfer.
15.	Characteristic criterion		Dimensionless complex consisting of physical values determining the given phenomenon and entering univalence conditions.
16.	Unknown criterion		Dimensionless complex consisting of physical values determining a phenomenon, but not entering univalence conditions.
17.	Bulygin number	Bu	Characteristic criterion. The criterion of highly intensive heat transfer. It characterizes the accumulating ability of a body due to heat required for formation of vapour taking part in a molar transfer. It may be determined from the expression: $$\frac{rC_b}{C_q}\,\frac{P_0}{t_c - t_0}.$$
18.	Gukhman number	Gu	Characteristic criterion. It is a thermodynamic evaporation criterion under isobaric–adiabatic conditions. It is determined from the expression: $$\frac{t_c - t_m}{T_c}.$$
19.	Kirpichev mass transfer number	Ki_m	Characteristic criterion. It is the Biot modified mass transfer number. It characterizes the intensity of external mass transfer in comparison with the internal intensity of a substance transfer. It is determined from the expression: $$q_m l / a_m \gamma_0 U_m.$$
20.	Kirpichev heat transfer number	Ki_q	Characteristic criterion. It is the Biot modified heat transfer number. It characterizes the intensity of external heat transfer in comparison with the internal intensity of heat transfer. It is determined from the expression: $$q_q l / \lambda \Delta t.$$
21.	Kosovich number	Ko	Characteristic criterion. It characterizes the relation between heat required for liquid evaporation and that for heating a body. It is determined from the expression: $$r \Delta u / c_q \Delta t.$$

No.	Term	Letter symbol	Definition of the term
22.	Luikov number	Lu	Characteristic criterion. It characterizes the velocity distribution of a mass content field with respect to a temperature field. It is the relaxation measure of the field of a potential of a substance transfer with respect to that of heat transfer. It is determined from the expression: $$a_m/a_q.$$
23.	Similarity number of physical and chemical conversions	K	Characteristic criterion. It characterizes the ratio of a heat flow, required for phase conversion of a substance, to heat of overheating (supercooling) of one of the phases. It is determined from the expression: $$r/C_q\Delta t \quad \text{or} \quad r/(i_t - i'')$$
24.	Temperature number	K_t	Characteristic criterion. It characterizes the influence of the surface curvature of the interface upon saturation temperature. It is determined from the expression: $$\frac{(r\gamma'')^2}{AC_qT''\gamma'\sqrt{[\sigma(\gamma' - \gamma'')]}}.$$
25.	Pressure number	K_p	Characteristic criterion. It characterizes the ratio of absolute pressure in a system to a pressure jump on the interface. It is determined from the expression: $$\frac{P}{\sqrt{[\sigma(\gamma' - \gamma'')]}}$$
26.	Phase and chemical conversions number		Characteristic criterion. It characterizes the ratio of a mass change due to the phase conversion, d_iU, to a mass change due to the transfer, d_eU. It is determined from the relation: $$\epsilon = \beta/1 + \beta\text{, where}$$ $$\beta = d_iU/d_eU.$$
27.	Posnov number	Pn	Characteristic criterion. It characterizes a relative drop in specific moisture content caused by a temperature drop in a stationary state. It is determined from the expression: $$\delta\Delta t/\Delta U.$$
28.	Pomerantsev number	Po	Characteristic criterion. It is the measure of the ratio of heat quantity released by a source per time unit in a parallelepiped volume with a base area 1 m^2 and l in height to the quantity transferred by heat conductivity through the layer l in thickness at the temperature drop t_c in it. It is determined from the expression: $$J_ql^2/\lambda t_c.$$
29.	Predvoditelev number	Pd	Characteristic criterion. It characterizes the intensity of medium temperature change with respect to a velocity temperature change of a body. It is determined from the expression: $$\left\|\frac{dt^*}{dF_0}\right\| \max.$$
30.	Efficiency number of heat transfer process	K_{eff}	Characteristic criterion. It characterizes the intensity of external heat transfer per unit of dimensionless hydrodynamic resistance of the system. It is determined from the expression: $$Fal\rho v^2/\lambda\Delta pt \quad \text{or}$$ $$Fav/C_qg\Delta Pf.$$

SYMBOLS NOT GIVEN IN THE TABLE OF TERMINOLOGY

λ, heat conduction coefficient;
C_q, specific heat capacity;
C_b, specific vapour capacity;
γ, specific weight;
ρ, density;
v, velocity;
P, pressure;
l, characteristic dimension;
F, heating surface of a heat agent;
f, cross-section for passing of a given agent;
a_q, thermal diffusivity;
r, heat of formation;
i, specific heat content;
q_q, heat flow;
q_m, flow of a substance;
t°, T°, temperature, respectively °C; and °K;
J_q, heat source power in a heat volume unit
σ, surface tension coefficient;
A, thermal equivalent of mechanical work;
$t^* = \frac{T_i}{T_0}$, relative temperature;
F_0, the homochronous Fourier number;
$'$, liquid phase;
$''$, vapour phase.

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Abstract—The paper presents a short historical review of the works of Russian scientists in the development of the science of heat and mass transfer. A table of specific terms, letter symbols and definitions used in the Soviet literature but not used on a large scale is given.

Résumé—Cet article fait une brève revue historique des travaux des savants russes dans le domaine du transport de chaleur et de masse, et donne un tableau des termes particuliers, des symboles et des définitions utilisés dans la littérature russe mais non à l'échelle internationale.

Zusammenfassung—Es wird ein kurzer historischer Überblick über den Anteil russischer Wissenschaftler an der Entwicklung der Lehre von der Wärme- und Stoffübertragung gegeben. Ferner wird eine Zusammenstellung besonderer Ausdrücke, Formelzeichen und Definitionen mitgeteilt, wie Sie in der russischen Literatur aber nicht international üblich sind.