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ENTROPY PRODUCTION EQUATION FOR THE OPEN SYSTEM AS A THEORETICAL BASIS OF ENERGY GENERATION FROM HEAT ENERGY OF ENVIRONMENT - PHYSICAL FOUNDATIONS OF TORNADO TYPE PHENOMENON

Aptsiauri A., Aptsiauri G.

Summary: *In the article is shown that the equation of entropy production that lies at the basis of the entropy permanent growth principle and second law of thermodynamics, not only is not suitable for justification of the second law, but vice versa. It is caused by the fact that, for open and closed systems, this equation gives radically different results. It shows that the theory of Carnot is only a special case and open systems have the ability to generate useful energy from the heat of the equilibrium space, which is particularly evident in the tornado. Thus, is given the theoretical basis (Ge-Theorem) for obtaining energy by the human from environment.*

Keywords: *Entropy production; open systems; energy generation; tornado.*

1. INTRODUCTION

Equation of entropy production was justified in fundamental works of Lars Onsager and Ilya Prigogine. In the most general form (with all the forces and fluxes), this equation is formulated on the basis of the Onsager reciprocity (or the principle of symmetry of kinetic coefficients). Despite the importance of this theory, in the works of many scientists is noted that this principle (as well as any) is not universal. In this paper, without considering the details of the principle of reciprocity and fairness of its application for the generalization of the entropy production equation, we demonstrate that the principle of a permanent increase of entropy is not universal and, for open systems, it can be grossly violated. To confirm the marked, we return to the original system of fundamental laws of mass, energy and momentum conservation, as well - as the Fourier law of heat conduction [1-4].

2. BASIC PART

For the case of viscous, heat-conducting gas, equation of entropy production is obtained by converting the equations of motion in the form of the Navier - Stokes equations and differential equations of mass and energy conservation:

$$\rho\frac{ds}{d\tau}=\frac{\mu}{T}\sigma(w)-\frac{1}{T}divq\,, \tag{1}$$

In this expression, $q=-\lambda gradT$ is the heat flux vector (Fourier's law). Speed function $\sigma(w)$ expresses the influence of dissipation. It depends on the strain tensor ($D(w)$) and compressibility ($divw$) of medium. From the structure of the strain tensor follows that this function is always greater than zero.

$$\sigma(w)=2D(w)^2-\frac{2}{3}(divw)^2\geq 0\quad . \tag{2}$$

Consequently, under the influence of the viscosity change of the entropy at a time is always directed towards its increase. However, as the last term of equation (1) shows, the influence of thermal conductivity and heat flow can lead to an increase or decrease in entropy along the flow. Below we show that this issue has very interesting nuances. To demonstrate this, we transform the original expression (1)

$$\rho\frac{ds}{d\tau}=\frac{\mu}{T}\sigma(w)+\lambda\left(\frac{gradT}{T}\right)^2-div\frac{q}{T}\ . \tag{3}$$

Primarily, it should be noted the limitations of the given equation. As you can see, the equation of entropy production is not suitable for determining the increase in entropy when we have flow with jumps (supersonic flow of gases with jumps of temperature, pressure and flow rate or with infinite gradients). According to (3), in such flows, the entropy increment tends to infinity. However, as is known, in the case of flow with jumps, thermodynamic state parameters changing is uniquely determined from the integral conservation laws [1] and the increase of entropy in the shock is not endless. In the work [10] is shown that if the gas with high heat conductivity is monotonically accelerated to supersonic speeds, and then there is a jump, then the total entropy increment can be negative and the stream will create a sucking effect, contrary to the requirements of the second law. In extreme cases, even from a qualitative analysis of the equation (3) is evident that entropy production equation is not universal for all physical processes.

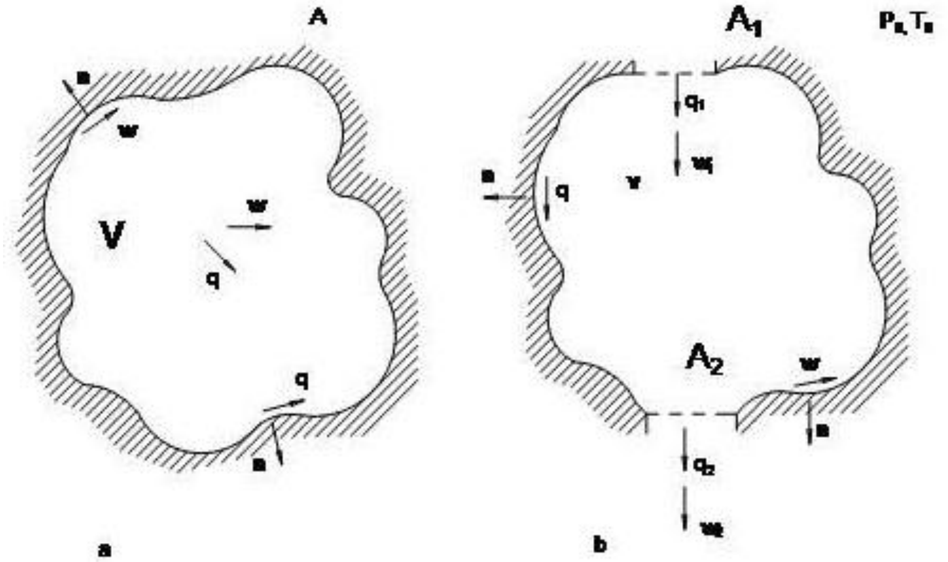

Fig.1. a- closed system. b - open system.

And now look what gives integration of the equation of entropy production. To this, taking into account the continuity equation, it can be represented as follows:

$$\frac{\partial\rho s}{\partial\tau}+div(s\rho w)+div\frac{q}{T}=\frac{\mu}{T}\sigma(w)+\frac{1}{\lambda}\left(\frac{q}{T}\right)^2\ . \tag{4}$$

We integrate this equation for some arbitrary, fixed volume V (Fig. 1) :

$$\int_V\frac{\partial\rho s}{\partial\tau}dV+\int_V div\left(s\rho w+q/T\right)dV=\mu\int_V\frac{\sigma(w)}{T}dV+\frac{1}{\lambda}\int_V\left(\frac{q}{T}\right)^2dV\ . \tag{5}$$

Or, using the Gauss - Ostrogradski conversion:

$$\frac{\partial(Ms)}{\partial\tau}+\int_A(s\rho w+q/T)ndA=\mu\int_V\frac{\sigma(w)}{T}dV+\frac{1}{\lambda}\int_V\left(\frac{q}{T}\right)^2dV\ . \tag{6}$$

where

$$Ms=\int_V s\rho dV=\int_M sdm\ . \tag{7}$$

We show the results given by the equation (6) for closed and open systems.

The change in entropy in a closed system

Let's look at the closed space filled with a liquid or gas (Fig. 1,a). In the case of system isolation through the limiting surface A does not pass the mass and heat. Consequently, in an arbitrary point of the bounding surface, with the direction vector n, this condition gives:

$$wn = 0 . \tag{8}$$

$$qn = 0 . \tag{9}$$

Therefore, (6) takes the form

$$\frac{\partial (Ms)}{\partial \tau} = \mu \int_V \frac{\sigma(w)}{T} dV + \frac{1}{\lambda} \int_V \left(\frac{q}{T} \right)^2 dV \geq 0 \ , \tag{10}$$

Thus, if in a confined space, in which, at a certain moment of time, there is unevenness in the distribution of speed and temperature (the initial unbalanced condition), the change in total entropy during the time will be directed only upwards. This result is a clear manifestation of the principle of steady growth of entropy. However, as we have seen, its validity is evident only in a closed system and, as will be shown, this principle is not universal for more general, open systems.

The change in entropy in an open system

Now let's look at the volume (Fig.1.b) within which from the equilibrium environment, through the surface A_1, the mass flows continuously. Through the surface A_2 a given amount of mass flows from volume. Ie we have the condition

$$\rho_2 w_2 A_2 = \rho_1 w_1 A_1 = G \ . \tag{11}$$

This condition is a stationary condition. This means that the flow parameters vary only in space. Accordingly, the equation (6) for such a process has the form.

$$\int_A (s\rho w + q/T) n dA = \mu \int_V \frac{\sigma(w)}{T} dV + \frac{1}{\lambda} \int_V \left(\frac{q}{T} \right)^2 dV . \tag{12}$$

At any given point of the boundary surface of volume, mass and heat flows are absent, so in such points are observed (8) and (9).

However, there are sections A_1 and A_2 where we have the mass flow and at the same time may be flow of heat. Therefore, the last integral takes the form

$$\rho_2 w_2 s_2 A_2 + \frac{q_2 A_2}{T_2} - \rho_1 w_1 s_0 A_1 - \frac{q_1 A_1}{T_1} = \mu \int_V \frac{\sigma(w)}{T} dV + \frac{1}{\lambda} \int_V \left(\frac{q}{T} \right)^2 dV , \tag{13}$$

or

$$s_2 - s_0 = \frac{\mu}{G} \int_V \frac{\sigma(w)}{T} dV + \frac{1}{\lambda G} \int_V \left(\frac{q}{T} \right)^2 dV + \frac{q_1 A_1}{T_1 G} - \frac{q_2 A_2}{T_2 G} \quad . \tag{14}$$

Thus, the sign of the entropy change in the open system, in general, is not necessarily positive. Everything depends on the fluid properties and flow conditions at the boundaries.

Violation of the second law

In classical thermodynamics, at one glance, is decisively proved, that the most effective way to convert heat into mechanical energy is the implementation of the Carnot cycle. However, in condition of thermal equilibrium (in the absence of bodies with different temperatures), even such most effective cycle can not generate usable energy from the equilibrium space. Consequently, in an equilibrium system, according to strict laws of thermodynamics, it is impossible to convert the heat into useful work. In addition to this, there exists a Carnot's theorem, which shows that the efficiency of cycle is independent from the properties of the working substance. So, all ways to efficiency are closed. For energy production people must necessarily look for high temperature heat sources, or how to burn some fuel. Here's the final verdict, which made man against nature - environment of own habitation.

Thus, the basis of profound scientific pessimism and ideological foundation for modern energy system - Carnot theory states that it is impossible to find a working substance (gas, liquid) and such technology, the use of which will generate useful energy from ambient heat. However, surprisingly, the fundamental principles of mass, energy and momentum conservation and entropy production equation (1 and 14) as their rigorous result, show the opposite.

If the properties of the working fluid have no value for improving the process of heat converting, let us consider the case of the flow of gas, which has a low viscosity and high thermal conductivity. Heat flux in equation (14) is one of the components of the total energy vector and at any point in space, in the case of steady flow, it can not exceed the total energy flux. Therefore, this value changes over a finite range. Accordingly, the volume integrals in the right-hand side of equation (14) should vary within a limited range. So, in this case, at

$$\mu \to 0 \qquad \lambda \to \infty \qquad \Pr \to 0 . \tag{15}$$

The right-hand side of equation (13) converges to zero and from (14) we obtain

$$s - s_0 = \frac{q_1 A_1}{T_1 G} - \frac{q_2 A_2}{T_2 G} . \tag{16}$$

If at the input we have low temperature gradients (small heat flow at the input), then

$$s - s_0 = -\frac{q_2 A_2}{T_2 G} . \tag{17}$$

I.e. entropy increase at the flow outlet is negative. Thus, if the stream follows from the limited space and in the jet of liquid, there exists a strong longitudinal parallel heat flux directed toward the surrounding area then the entropy of the effluent will be lower than at the inlet. This result is paradoxical, since completely violates the principle of Carnot and contradicts to the second law of thermodynamics. In particular, as is known, in the case of a heat-insulated flow, full pressure (or the brake pressure) is determined from the equation:

$$P^* = \frac{P_0}{\exp\left(\dfrac{s - s_0}{R}\right)} . \tag{18}$$

Therefore, if the entropy of the gas at the outlet is less than the original, then the total pressure of the effluent will be higher than the original pressure of incoming stream (or ambient pressure) and maintaining of the flow not only does not requires a blower, but on the contrary, the excess pressure at the outlet can produce useful energy. At the same time, such a process will cause a corresponding reduction in flow temperature. Thus, based on the fundamental laws, we have shown that in the nature there are more optimal processes than the Carnot cycle, which considers only schematized processes in the simplified system. For this reason, the theory of Carnot is unsuitable for formulation of universal principles and the second law, in the existing wordings has no convincing basis. Based on the above, we can formulate the following theorem:

Ge – Theorem - If in the random, heat-isolated volume exists stationary gas transit and in the leaving jet there is a predominant heat flow, directed towards the surrounding space, at intensive internal heat transfer and minimal friction inside the space ($\Pr \to 0$), the entropy of escaping gas may be less (a braking pressure - more) than at the inlet, creating thus self-supporting effect, or an effect of useful energy generating from heat of equilibrium environment.

Unfortunately, the molecular heat conductivity of liquids and gases is quite low. Along the mass flows can not be significant flows of heat and this effect often can not overcome the negative effect of viscosity at normal scales of flow. However, these strange effects may be observed in the nature on the large scales. As visual manifestation of such phenomenon it can be considered a tornado.

Many authors believe that the spiraling flow creates a sucking effect. First about this strange phenomenon is given information in the works of V. Schauberger and F. Popel, In the middle of the last century they explored flows in the spiral channels. Subsequently, about the presence of a self-sustaining effect inside the tornado was written so many times that we do not enumerate all these authors, thinking boldly, in conditions of mistrust on the part of representatives of classical science. The majority of these works has one drawback, they are not clear from the position of the physical nature of this phenomenon and they do not answer - how to destroy erroneous theoretical foundations of classical thermodynamics. In our studies [10] is theoretically proved that classical thermodynamics is not universal for more general, open systems. It was shown that the redistribution of internal energy in the swirling flow, in fact, leads to the mechanical energy generation effects from the heat. Similar mechanisms may occur at synchronization of turbulent and cavitation flows [5,9]. Not to mention the processes with chemical transformations [8].

Process inside a tornado can be considered as a special case of the processes in which there is an apparent cooling due to internal heat circulation (or implosion - in terms of Schauberger). Specific calculations, we carried out, showed that while respecting the laws of mass, energy and momentum conservation, as well as in compliance with the terms of the Fourier law, in condition of a very high value of the coefficient of thermal conductivity (conditional coefficient of thermal conductivity at very strong turbulence), the entropy of an isolated flow permanently falls, despite the principle of entropy permanent increasing. Consequently, there is a pronounced effect of mechanical energy generation from heat that can be considered as one of the main reasons of the stability and the destructive power of a tornado.

3. CONCLUSION

Principle of entropy permanent increase and the theory of Carnot about the impossibility of useful energy continuous generation from the equilibrium space (or second law), are valid only for closed systems. Under the conditions, that are outlined in the proposed Ge - theorem, in open systems, mechanical energy can be continuously generated from the heat of the environment, as, in particular, we have in the case of tornado.

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