THERMODYNAMICS AND HUMAN SOCIETY

Mihai JĂDĂNEANȚ M.Sc, Ph.D.
Professor, Politehnica University of Timisoara, Bv. Mihai Viteazul nr.1, 300222 Timişoara
tel. +40-256-403668; fax. +40-356-810588; E-mail: mihai.jadaneant@mec.upt.ro

Abstract: *The universe can be seen as a complex thermodynamic system, build from a lots of small or bigger thermodynamic systems. Generally the greatest urbane throngs are characterized by a large number of motor vehicles. The lots of motor vehicles from the big cities can be seen as a thermodynamic system which interferes with the environing system. This interaction vehicle-environment, and other systems interaction which generates energy-environment are discussed on the base of entropy in this paper.*

Key words: thermodynamics, entropy, second law of the termodynamic.

1. Entropy; exergy and anergy.

Since it was introduced by Rudolf Clausius in 1865, the function called entropy enjoyed a great interest from the scientists and the technicians. Although at the beginning the entropy wasn't so popular, in no time it rose up to a key level in the termodynamics and it was also taken over in other science fields, that at the first glace do not have any touch with this notion.

Unlike other physics parameters used in the thermodynamics like the temperature or the pressure, the entropy is an abstract parameter, whitout any physique correspondent that can be directly infered. Gradually it found numerous applications, providing itself extremely productive in the study of thermic engines and in other fields.

Once with the growing of ist applications it come out that entropy wasn't more misterious than other thermodynamic parameters, such as the specific heat and the physique sense of entropy isn't as difficult to realise as it seemed at the beginning.

The entropy as Clausius defined it may be considered as a measure of the preferential sense of the thermal transformations and of the irreversibility of the thermodynamic processes. Considering the entropy as a statistic parameter, Ludwig Boltzmann established a relationship between entropy and probability. On this way, the entropy becomes a measure of disturbance of the systems. This wording allows using entropy in the informatic, the economic, the social and the biological range. Thus, in our day we can't use entropy generally, but we have to specify if it is about the termodynamic entropy, statistic entropy, informational entropy or social entropy.

Among the physical parameters, the entropy occupe a specific place. Representing one of the most curious physical draft, hard to infer and define other than mathematical, the entropy penetrated fast into the deep areas of the human mind. This thing is been due to ist feature of developing in single sense, that mean to be irreversible. Through enuncianting the entropy's irreversibility, Clausius attributed this parameter one feature which had till than only the time.

Using the entropy in case of the heat exchange into adiabatic system (figure 1), it was established that the entropy of this systems increases; the increasing is been due to the irreversibility of the process:

$$\Delta S = dS_{ir} = dS_A + dS_B = dQ\left(\frac{1}{T_A} - \frac{1}{T_B}\right) > 0 \quad (1)$$

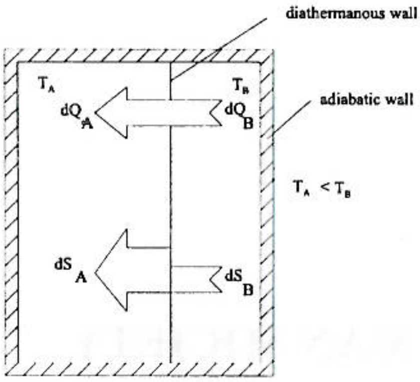

Figure 1. The heat exchange into an adiabatic system.

Extending the analysis to all irreversible processes it was established the entropy law: *the entropy of an adiabatic system doesn't decrease. At all irreversible precesses, the entropy of an adiabatic system increases and at the reversible processes it remains constant.* Therefor, results that *the thermodynamic equilibrium state to which tends any system it is characterized through maximum entropy.* But we shouldn't forget that this equilibrium state means whole disorder.

An important aspect of the relationship which defines the calcul of the difference of entropy between two states is that the difference of entropy is established in the evolution sense of time, from the moment soonser to the moment later.

Close thight to the concept of entropy are the notions of *exergy (availability)* and *anergy* (Ex and An). Through exergy it is known the energy that can be integral changed into another forme of energy. Anergy instead, can not change into exergy. Any energy is made out of exergy and anergy where one of them can be missing.

Energy = Exergy + Anergy

Refering to a heat exchange between two systems it can be written the following (figure 2):

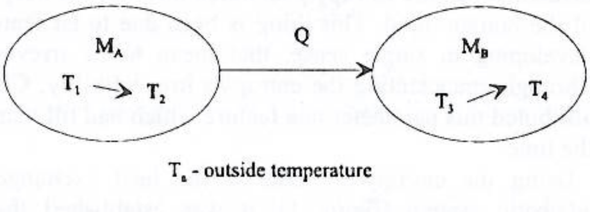

Figure 2. The heat exchange between two systems.

- The available exergy:

$$Ex_A = m_A \int_{T_1}^{T_2} \left(1 - \frac{T_a}{T}\right) \cdot c_{pA} \cdot dT =$$

$$= m_A \cdot c_{pA} \cdot (T_2 - T_1) - m_A \cdot c_{pA} \cdot T_a \cdot \ln \frac{T_1}{T_2} \qquad (2)$$

or with the concept of logaritmic mean temperature introduced by P. Le Goff [2]:

$$T_{mlA} = \frac{T_1 - T_2}{\ln \dfrac{T_1}{T_2}}$$

$$Ex_A = Q \cdot \left(1 - \frac{T_a}{T_{mA}}\right) \qquad (3)$$

- The received exergy: represents the exergy received by the system B, if this received the whole heat given by system A:

$$Ex_B = Q \cdot \left(1 - \frac{T_a}{T_{mB}}\right) \qquad (4)$$

- The lost exergy: the part of the available exergy lost during the heat exchange:

$$Ex_p = Ex_A - Ex_B$$

$$Ex_p = Q \cdot \left(\frac{T_a}{T_{mlB}} - \frac{T_a}{T_{mlA}}\right) \qquad (5)$$

It is known that the lost exergy can be calculated also with the relationship:

$$Ex_p = T_a \cdot (S_2 - S_1)_{adiab} \qquad (6)$$

where the system is considered adiabatical.

For analysing the perfection level of the energetic transformations and establishing the causes that appear in a certain process, it is esed the exergetic-anergetic flux diagram unlike the energetic flux diagram which praises the places where the lost is made. Certainly, this diagram can not be build then after were calculate the entropy's raises for all the irreversibilities of that process. In figure 3 was represented the exergetic-anergetic flux for the heat exchanging dQ between the system B and A, that were previously analysed on the basis of figure 1. Known the temperatures T_A, T_B and T_a it can be calculated dEx, dAn and dEx_p with the previous relationship.

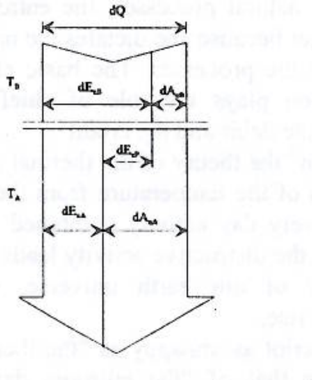

Figure 3. The exergy-anergy flux diagram for the heat exchange.

But if the exergy loses are made in an nonadiabatic system, then it is considered also the environment with whom it exchanges heat too, and it is calculated *the entropy variation of the whole system known as adiabatic*, as an algebraical sum of the etropies variations of the two constitutive systems.

We shall consider an thermodynamic system for analysis (figure 4).

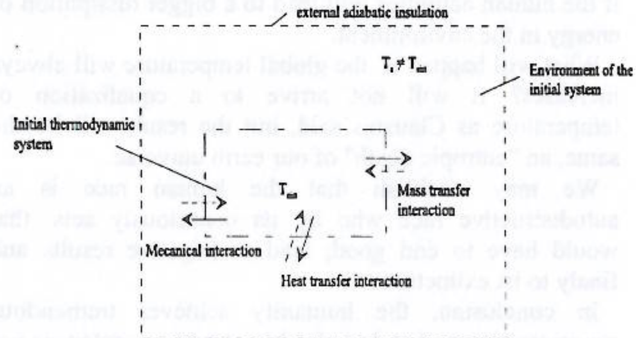

Figure 4. The interactions of a thermodynamic system.

Beside the normal mechanical and thermal interactions, we shall consider the system like a thermodynamik open system, also having an interaction through mass transfer (m). Obviously, the entering of the heat carrier is doing discontinous (a fuel feeding as well), but the scavening is continous, as long as the thermodynamic system is working. Considering the thermodynamic system is working between two extreme states 1 and 2, for the hypothesis of reversible processes, the first law of the termodynamic can be write:

$$q_{12}^{rev} = i_2 - i_1 + l_{t12}^{rev} \qquad (7)$$

The agent's heat exchange with the environment is clearly equal and negative sign with the environment's heat exchange by heat carrier; as a result the environment's entropy is changing with ΔS_a^{rev}, ist temperature is remaining constant and equal T_a:

$$Q_a^{rev} = T_a \cdot \Delta S_a^{rev} = -q_{12}^{rev} \qquad (8)$$

Considering the process irreversible, it results:

$$q_{12}^{irev} = i_2 - i_1 + l_{t12}^{irev} \qquad (9)$$

and

$$Q_a^{irev} = T_a \cdot \Delta S_a^{irev} = -q_{12}^{irev} \qquad (10)$$

The lost of mechanical work because of the internal and external irreversibilities of the processes is:

$$\Delta l_t = l_{t12}^{rev} - l_{t12}^{irev} = T_a \cdot \left(\Delta S_a^{irev} - \Delta S_a^{rev}\right) \qquad (11)$$

If we include the initial thermodynamic system and the environment in a *more general thermodynamic system*, izolated from the rest of the largest environment (figure 4), it results that for this new system, the entropy balance equation has two expressions:

$$\Delta S_{sist.gen}^{rev} = \Delta S_a^{rev} + \left(s_2 - s_1\right)_{agent}^{rev} = 0 \qquad (12)$$

$$\Delta S_{sist.gen}^{irev} = \Delta S_a^{irev} + \left(s_2 - s_1\right)_{agent}^{irev} > 0 \qquad (13)$$

It results that:

$$\Delta S_{sist.gen}^{irev} = \Delta S_a^{irev} - \Delta S_a^{rev} > 0 \qquad (14)$$

In all those entropic analysis interferes in a dogmatic way the claim that *the environment's temperature T_a remains constant.*

Let's talk about the system from figure 4. The thermodynamik system gives heat to the near by environment, which can be seen as an adiabatic insulated by the generalized environment. This adiabatic insulation can be better understood if we make analogy between the system from figure 4 and a coal storage or a grain store where it can burst an selfignition begining from inside material stored, because each material layer responses as an adiabatic cover for the space locked.

As a result of the irreversible heat exchange, the entropy's system increases (figure 1), and *the temperature of adiabatic system increases too.*

2. The entropic analysis.

The system built from the thermodynamic system and the environment can be bonsider as a system which gives heat to the near by environment and the entropy and the temperature of this system increases.

All microsystems built from lots of motor vehicles from a town and the environment that surrounds them form a macrosystem which interacts with the near by environment in the sense of the entropy's increasing but also in the sense of the temperature's increasing. The same will happen with all the systems that release thermic energy when working: thermoelectric power stations, space rockets when launching, human conducted or accidental activities, local wars and others, they will actuate in the sense of the entropy's increasing but also in the sense of the temperature's increasing.

The debate till now is sugesting a stationary state. Absolutely normal, the environment is always moving, with a dynamics hard to anticipate and to estimate. But even in the case of the real dynamic process, the above detailed interactions exist and can be estimated the entropy's increasing of the air from the environment in the first place, and obviously ist temperature.

Considering the thousands of urbane agglomerations to act as some systems where had taken place the increasing of the entropy and the temperature of the environment, it is undoubtable that this huge but finite reservoir, mostly the air from the environment stores more and more entropy, meanwhile the temperature is increasing.

Further the scripts can be multiply. One of them is that a huge amount of air whose entropy and temperature have increase because of the phenomenous described previously is behaving at a moment as an adiabatic system with a considerable part of the planetary ocean. The air will release heat to this amount of the ocean, the entropy will increase and so the tempearture of the ocean will increase too. This can be an explanation for the devastator phenomen known as "El Niño".

From the debate about the heat transfer systems we shouldn't forget onces of the most intense processes of punctual heat exchange. Even if they don't frame in the strict field of the vehicles, they are after all vehicles. It is about the space rockets and the space shuttless which in the period of their launching release a huge amount of heat and the model proposed by the vehicle-environment as an adiabatic system firs better because of the very short time of the heat exchange. In my opinion the impact with the environment is more devastator than the one made by earth vehicles.

Also in the frame of this punctual heat exchanges we can introduce the lots of blasts and fires that have taken place during a war, such as the one from Yogoslavia.

The classical thermodynamics refers to reversible processes for which the entropy remains constant in any insulated system. In fact, all natural processes that occur in such systems take to a increasing of the entropy. This production of entropy due to the irreversibility of the process is the fundamental parameter in the irreversible processes thermodynamics. In Onsager, Bridgman and Eckart's papers fromthe thirties it is shown that all the phenomenological laws known till then could be interpreted as dependences between the factors of the production of entropy. The theory was taken further through Progogine and Meixner's papers and can be considered finished for the phenomenons from single-phase systems. In 1960 Meixner [6] wrote: "In the huge factory of natural processes, the entropy production is the manager because she dictates the nature and the way of making the processes. The basic element of energy conservation plays the role of chief accountant that equalizes the debit and the credit".

Clausius in "the theory of the thermal death" forsaw the equalization of the temperature from the inside our earth universe. Every day activity combined with the creative activity and the distructive activity leads to a quick rise of the entropy of our earth universe, meanwhile to a temperature rise.

Another script as unhappy as "the thermal death of the universe" is that of "the entropic death of the earth universe" as a result of the continous increasing of the earth universe's entropy and then the increasing of ist temperature. There will be temperature differences dues by the existence of hot sources (differents fuels), but the increasing of the earth universe's temperature can be catastrophic; the messengers of these phenomenons knock at the door of our earth universe: there isn't a normal succession of the seasons, there are distructive phenomenons (floods, tornados, hurricanes) even in regions where they never existed.

It was already established an alarming tendency of global heating. This tendency can continue and accelerate if the human activities will lead to a bigger dissipation of energy in the environment.

What will happen if the global temperature will always increases? It will not arrive to a equalization of temperature as Clausius said, but the result will be the same, an "entropic death" of our earth universe.

We may establish that the human race is an autodistructive race who by its consciously acts, that would have to end good, lead to negative results and finaly to ist extinction.

In conclusion, the humanity achieves tremendous progresses every day, but also by ist actions sentences our finite universe -the Earth- to get close with a higher speed to stage of ist maximum entropy.

References:

[1] H. Theil : *Conceptul de entropie în ştiinţă şi tehnică*, Energ 3, Editura Tehnică, 1987.

[2] R. Rivero, S. de Oliveire, P. Le Goff: *Temperature de Carnot Θ, Diagrama Θ/Q, Méthode du pincement*, Entropie nr. 157/158, 1990, p.13/20.

[3] Vs. Radcenco – *Criterii de optimizare a proceselor termice*, Editura Tehnică, Bucureşti, 1977.

[4] A. Bejan - *Termodinamică tehnică avansată*, Editura Tehnică, Bucureşti, 1996.

[5] M. Jădăneanţ – *Termodinamică tehnică*, Editura Orizonturi universitare, Timişoara, 1998.

[6] I. Meixner - *Phys. Blätter* 16 (1960), S. 506.