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LIFE LAWS AND RATIONAL USE OF AMBIENT HEAT EXERGY

Research article

Abstract

In the Article, the systemic deductive approach is given to revelation and overcoming of the delusion in sciences caused its development retardation for more than 150 years. The approach use "from methodology to ontology" allowed deducting the trialectical concept of natural history [4]. It consists of the survival law, essence of which is opposite to that of the second law of thermodynamics. The survival law and the law of entropy increase are bound up inextricably with each other in the form of the reflective dynamic symmetry and being taken together, they form the natural history general principle, namely the energy extremality of self-organization and progressive evolution. The natural paradigm "life–death" reflects three in one: the law, the basis and the principle formed by them confirming their reliability.

Keywords: the second law of thermodynamics, the trilectic concept of natural science, exergy, exergy of energy conversion, exergy of external heat transfer, phase transition: evaporation – condensation, circulation of water, exergy efficiency rate, heat pumps, refrigerators, heat engines, the survival law.

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ЗАКОНЫ ЖИЗНИ И РАЦИОНАЛЬНОЕ ИСПОЛЬЗОВАНИЕ ТЕПЛОТЫ СРЕДЫ

Научная статья

Аннотация

В статье изложен системный дедуктивный подход к выявлению и устранению заблуждения в науке, вызвавшего задержку ее развития более чем на 150 лет. Использование подхода "от методологии к онтологии" позволило выявить триалектическую концепцию естествознания [4]. Она состоит из закона выживания, сущность которого противоположна сущности второго начала термодинамики. Закон и начало неразрывно объединены в виде зеркальной динамической симметрии и образуют общий принцип естествознания – энергетическую экстремальность самоорганизации и прогрессивной эволюции. Естественная аксиома "жизнь–смерть" одновременно отображает закон, начало и образуемый ими принцип, подтверждая их достоверность.

Ключевые слова: второе начало термодинамики, триалектическая концепция естествознания, эксергия, эксергия преобразования энергии, эксергия внешнего теплообмена, фазовый переход: испарение - конденсация, циркуляция воды, коэффициент эффективности эксергии, тепловые насосы, холодильники, тепловые двигатели, закон выживания.

1. Introduction

The survival law and the entropy increase principle taken together direct the nature progressive evolution. The second law of thermodynamics and the entropy being its function destroy structures of objects having get back out of their self-organized state & become available for them. They form the cycling of matter participating in the evolution through organisms–decomposers. At the same time, those natural objects, which stay still in their self-organized (living) state, continue functioning in their normal ways and come into existence again in accordance with the survival law as they are inaccessible for the thermodynamics second law and the entropy action. It was found out that the addition of the generally accepted theories of the

natural history by the survival law and the principle of the energy extremality of self-organization establishes the natural-sciences-backed basis of the practical pan-unity of knowledge. It allows theorizing of non-formalized knowledge sectors and their logical uniting with the sciences.

Irrefutably, the available scientific facts of evolution and Earth biosphere functioning confirm the credibility of this concept. Earth the planet has no regular matter exchange with its environment. Thermodynamically, it is a closed system on a matter exchange. Any evolution on it is possible only due to the cycling of matter participating in the evolution. The fact of this matter cycling was reliably established as early as in the XIXth century; however its fulfillment law and mechanism was not found out. The properties and essence of the thermodynamics second law and the entropy increase principle correspond to this natural process including organisms–decomposers. They decompose structures having get back out of objects' self-organized state and form the cycling of biogenic matter in the biosphere. At the same time, the objects still staying in their self-organized state continue their normal functioning and anew they are coming to existence in concord with the survival law as they are inaccessible for the thermodynamics second law and the entropy action.

2. Trialectic concept of natural history: Main law of living nature, its self-organization and energetics; General principle of natural history

According to the Thompson–Clausius hypothesis introduced based on the achieved science state by the middle of the XIXth century, the nature evolution is directed by the thermodynamics second law and the entropy action as its function [2]. This caused a number of problems in the sciences and slowed the development of knowledge about the life. While discussing these problems, scientists predicted existence of a law, essence of which would be opposite to that of the thermodynamics second law. Such law has been found out and this is the survival law. Inseparably, in the form of the reflective dynamic symmetry, it is connected with the thermodynamics second law and together they form the united principle of the natural history and this is the energy extremality of self-organization and progressive evolution.

The Thompson–Clausius hypothesis would be correct if the matter of the Universe (cosmic space) were in its balanced (non-self-organized) state. The modern researches devoted to cosmic space matter and conducted under the guidance of the academician of Russian Academy of Science E.M. Fortov together with German scientists showed that around 90% of visible cosmic space matter stays in the form of plasmas. Those are plasma of cosmic dust and plasma inside of cosmic bodies. The both kinds of plasma contain plasmatic crystals being self-organizing objects [3]. By this fact, the falsehood of the above-mentioned hypothesis has been proved. In the duration of more than 150 years, several generations of scientists all around the world tried solving the problems of sciences laid by the above-mentioned hypothesis. Apparently, the failure of those efforts was conditioned by the contest that all of them were conducted based on the dialectic logic; however, if to stay inside of its limits, it is impossible to explain the natural process of the transition from the balanced state to the self-organization. This phenomenon can be explained in the frame of the logic of triplicity.

After excluding the wrong hypothesis from the science and its supplement by the survival law understood as the principle of the energy extremality of self-organization, we shall obtain the natural-science-relied basis of the practical pan-unity of knowledge allowing theorization of non-formalized knowledge sectors and their re-joining to the natural history theory. This has been shown on the example of theorization of agro-ecology and agro-technology [1].

The survival law directs the progressive evolution of the nature, while the thermodynamics second law and the entropy action utilize structures of natural objects having get back out of their self-organized state & become balanced and available for the second law. By organisms–decomposers inclusion into the process, they form the cycling of matter participating in the evolution. Irrefutably, this is confirmed by the accumulated scientific facts of the biosphere evolution and functioning. The survival law is the main law of living nature, of its self-organization and energetic behavior. The principle of the energy extremality of self-organization and progressive evolution is the main principle uniting all the natural history [1], [5].

3. Essence of survival law reads as follows: Inadvertently, every element of the self-organizing nature in its development (both individual and evolutionary) tends to a state of the fullest use of available free energy by a system of trophic level, to which it belongs

Analytical expressions of the survival law are similar to expressions of the thermodynamics second law with the only exception that the right part of the expression has negative value (sign minus). In the nature, the survival law shows itself in the form of a lot of different phenomenal mechanisms (phenomena), which are established reliably in empiric or mathematical ways but have not been explained yet based on the natural sciences. To the latter, the extreme physical–chemical principles belong such as: Fermat principle, principle of the least action in the form proposed by Maupertuis and in that by Hamilton, Le Chatelier principle, Lenz's law of electric magnetic inertia as well as phase transitions of the first kind: proton – neutron interactions. To them, solitons belong, as well as fractals, golden proportion and many other phenomena having not been revealed yet. All of them can be explained and united by the survival law [1].

Mechanisms of the survival law action were selected and conserved by the progressive evolution of the nature through all stages of its development from micro-particle up to Homo Intellective. As an example to it, the three-link fractal structure of matter can serve. Proton being its primary carrier consists of ten steps of this fractal; also the evolutionary tree of biosphere's organisms species consists of links of the same fractal, on the top of which the human stays [1]. This fact allows suggesting that the used in the chemistry term "matter congeniality" can be extended to micro-particles as well as to more and more complicated matter carriers if to add the word "structural" to this term. Apparently, the structural congeniality of matter leads to inadvertent orientedness of the progressive evolution to economy of main resources of the nature, i.e. energy, matter and space.

This inadvertent tend of the progressive evolution to frugality of resources guarantees the beauty and the harmony of evolving self-organizing objects, in particular, living ones. Along with the over-complication of the evolving objects, their evolution is accelerated. These truly ideal inseparable properties of the progressive evolution of the nature are opposite to the anxiety about the "heat death of Earth and Universe" arisen by the mentioned above hypothesis. These inseparable truly ideal properties of the progressive evolution of the nature would be appropriately represented in the form of holon, which is – according to Plato – an object of the highest hierarchical level of the self-organizing nature. This holon is found out by development analysis of knowledge on the evolution on the basis of theses of knowledge pan-unity concept [6].

The survival law is substantiated based on the analysis of organisms' subsystems of sustainment. In organisms, the processes of matter/energy exchange and realization of controlling or informational processes run at the same time and in the same structures. Physically, these processes are inseparable. Their mental separation allows revealing their inter-subordination as well as that one from them which restricts principally the development of the living nature. Evolutionists believe that as a departure point of the evolution theory, Ch. Darwin took the "struggle for existence". Factually, as the departure point of his theory, he took another point reading as follows: "Without exclusion, all species proliferate in geometrical progression" [8]. The first conclusion from this point is overcrowding and only second one is the struggle for existence. The analysis of organisms' sustainment subsystems allows concretizing the resource, for which the struggle takes place.

Among the subsystems, the one of matter exchange is most studied. If to consider any substance, for example, water, which being penetrated once through an organism, after regeneration, can be used repeatedly by this or similar organism. For the regeneration, it is necessary to spend energy. The matter exchange can be secluded in part or in full. Principally, it does not limit a development of organisms and the living nature as whole.

The basis of the organisms' sustainment informational–controlling subsystem is made of their genetic information. In populations able to reproduction, this information transit from a generation to a generation and is capable to circulate in the population for a long time. Also this subsystem does not impose principal limitations on a living nature development.

A peculiarity of the subsystem of energy exchange consists in the fact that an energy entered to an organism is used by it. It transforms into the low-quality heat energy, which is not suitable for a repeated use by this or that organism. The subsystem of energy exchange imposes the principal limitation on the development of the living nature. To it, the subsystems are subordinated of matter exchange and informational or controlling processes. Judging on this consideration of organisms' sustainment subsystems, it might be accepted that the specific resource being a goal of organisms' "struggle for existence" is the available for them free energy.

Let us note that this principal energy-based limitation of the living nature development was also revealed in statistical researches of world countries development devoted to finding out limits of their growth mentioned on the first reports of Roman Club. Those limits for all the states are posed by availability of energy resources for them [9], [10]. Notwithstanding the possession of the special property such as the ability of thinking, in its practical activities, the mankind has not overcome yet this principal limitation of the living nature development.

4. Indirect experimental verification of survival law

A direct empiric verification of the survival law is impossible in the same reason that exists for the second law of thermodynamics. As the departure point for our indirect verification of the survival law, the statement was used that in the evolution process, plants adapted to the spectral composition of the solar emission (light) coming to Earth surface. According to this generally accepted point, traditionally at selection of electric sources of optic emission for the plants ray treatment, biologists tended making so that their spectral composition of emission in visible area of waves corresponded to the solar one. In the plants light-physiology, this requirement was considered as the main one for effectiveness assessment of artificial light sources used for plants growing [9], [10], [11]. It limited principally a possibility of a selection from among existing sources and of substantiation of new energy-saving electric sources development for plants cultivation.

Without disputing of fairness of this statement, there was taken by us to attention the existence possibility of a law of a higher level of generalization, which must prevail over the evolutionary adaptation of plants to the spectral composition of the solar emission at Earth surface. Such law can be the survival law, according to which plants are able to use effectively the emission energy suitable for plants' photosynthesis and let it be of any spectral composition if any harmful for plants components are absent in it.

Relying on this, new requirements were developed to energy-saving electric sources for plants cultivation. In them, the point was excluded about the necessity of approximation of the spectral composition of an artificial source emission to that of solar one. Among them, the main requirement was about achievement of maximum of useful action (power efficiency) of emission source in relation of the plants photosynthesis ($\eta_{u\phi}$), which can be limited in line with the expression [13], [14]:

$$\eta_{u\phi} = 0,95 \int_{\lambda_1}^{\lambda_2} \varphi(\lambda)K(\lambda)_{\phi} d\lambda / P_{en} \rightarrow \max \quad (1)$$

where 0,95 is top spectral effectiveness of photosynthesis emission with wave length 680 nm; $\varphi(\lambda)$ is function of spectral distribution of emission energy; $K(\lambda)_{\phi}$ is function of spectral effectiveness of photosynthesis; λ_1, λ_2 are lengths of waves respectively 300 and 750 nm; P_{el} is electric power consumed by a source (lamp).

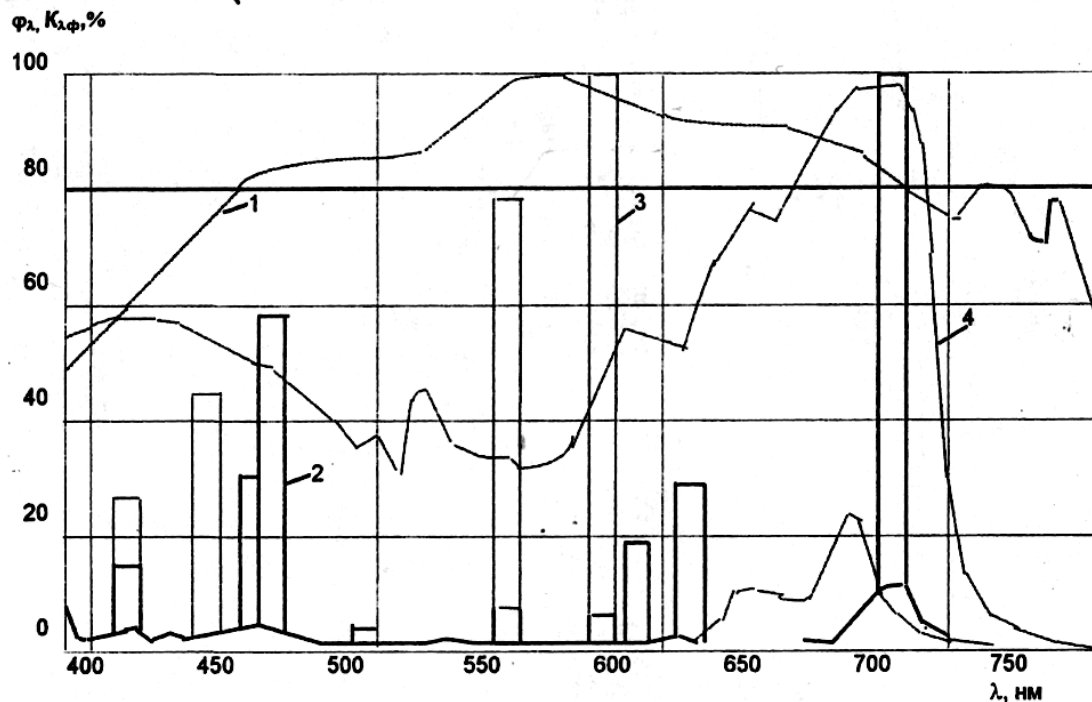


Figure 1 – Distribution of emission on specter φ_λ : 1. solar emission at Earth surface; 2. lamps DRLF-1000; 3. lamps DRL-1000; 4. spectral effectiveness of photosynthesis $K_{\lambda\phi}$

Such quantitative requirement to an energy-saving source for plants ray treatment principally extended possibilities of designers. By introduction of iodides of lithium and indium into mercury arc of high pressure, the energy-saving electric lamp (model DRF-1000) was designed, emission spectral composition of which is focused in main in the line of red emission of lithium (680 nm) and blue emission of indium. The green emission in the specter of this light source is relatively not large (Fig. 1, line 2). At comparison between the emission spectral composition of the lamp DRF-1000 and the solar one at Earth surface (Fig. 1, line 1), it can be called being “opposite to solar emission”. In the solar specter, maximum falls on the green emission and besides, its specter is complete and continuous. At the lamp DRF-1000, the specter is linewise and its maximums fall on red and blue areas of the emission.

Many-years comparative tests of the lamp DRF-1000 were conducted; as a control lamp, the similar one was used, which was pure mercury lamp DRL-1000. At cultivation of various plant species in conditions of purely artificial ray treatment, the comparative tests showed that all plant species selected for the experiments (strawberry, cucumber, lettuce, radish, wheat, tomato) grew, developed and fructified in normal way. The experiments confirmed the higher estimated energy-saving effectiveness of the lamp DRF-1000 (by 80%) as compared with the control mercury lamp of similar type DRL-1000, the emission spectral composition of which was closer to solar one (Fig. 1, line 3). These experimental results speak for the fact that notwithstanding the evolutionary adaptation of plants to the spectral composition of the solar emission, the tested six species of plants grow, develop and fructify in normal way under the artificial emission with the spectral composition much different from that of the solar emission. Thereby indirectly, the reality is confirmed of general bioenergy-orientedness of structures and functions of living systems and thus the reality of existence of the survival law. At the same time, these results demonstrate the high effectiveness of the survival law consideration at solving of practical problems in the area of agro-energy issues.

5. Energy dynamics (synthesis of theories of energy transfer and transformation)

While writing the book with this title, its author Valery Abramovich Etkin used the deductive systemic approach, too. He developed it based on the general thermodynamic (hypothesesless) theory of processes velocity of transfer and transformation of energy of any form regardless of their belonging to this or that area of knowledge [14]. Using the deductive method, unfortunately, the author of this book did not take into account the highest level of the methodology of science, which is philosophical level. This attitude did not allow him revealing the logical triplicity of the transition from the balanced state of natural objects to their self-organization and on contrary.

This transition is impossible to be correctly explained in frame of the dialectic logic and even less based on a single law – the second law of thermodynamics. (This was what several generations of scientists tried to make during more than 150 years. In general, this transition process runs within a certain time interval and consists of two mutually connected polar-opposite processes: 1) progressive constructive, evolutionary one and 2) destructive, utilizing structures of natural objects having get back out of their self-organized state. Hence, for its fulfillment, two laws are necessary with polar-opposite essences: the survival law and the second law of thermodynamics, which are inseparably connected, as it should be expected. It is no coincidence that this connection has the form of the reflective dynamic symmetry uniting them into the general principle of natural history, the energy extremality of self-organization and progressive evolution.

Also it is no coincidence that the natural paradigm “life – death” was revealed, which reflects simultaneously the survival law, the second law of thermodynamics and the formed by them general principle; axiomatically, the paradigm confirms their reliability. V. A. Etkin in [14] proposed his systemic approach to sciences integration based on the theory of speed of transfers

and conversion of any form of energy "regardless of their belonging to this or that area of knowledge". For the first time in the energy engineering, he paid due attention to the processes of energy transfer putting them ahead of processes of energy transformation [14]. Notwithstanding that every day by our own body, we feel the gravitational energy transfer, in publications in the energy engineering area, this kind of energy manifestation is mentioned very seldom.

The second kind of energy transfer from the ambient heat is realized in refrigerators and heat pumps. A practical possibility of this transfer use was discovered by the eminent physicist W. Thompson–Kelvin in the form of refrigerating machines and dynamic heating-up (afterwards, heat pumps); however until now, it has obtained no due scientific explanation. The work principle of these energy transformers is explained by a mythic "reverse Carnot cycle", which differs from the direct Carnot cycle with the fact that in its frame "rotation runs not clockwise but instead counter-clockwise".

Everyone, who understands the work principle of refrigerators and heat pumps, knows the following. In them as a working process the natural self-organizing energy-saving phenomenon is used, which is the phase transition of liquids, evaporation – condensation. Due to this phenomenon in the nature, the cycling of water takes place. The opinion is widely accepted that water flows only downwards; but due to evaporation, the same mass of it "flows upwards" as downwards. In a process of chaotic motion, while overcoming forces of liquid superficial tension, most fast-moving molecules of the liquid evaporate and bring away a part of heat energy with them. After their relocation into a medium with higher temperature and their kinetic energy decrease, those molecules are condensed along with release of energy taken by them from a body with lower temperature. This is how the transfer of heat energy runs from bodies with lower temperature to bodies with higher temperature. This takes place because of essential differences in kinetic energy level of chaotically moving various molecules of the liquid used as working body in these transformers.

A temperature of a body, for example, water, characterizes a middle velocity of the chaotic motion of its molecules; however, velocities of motion of separate molecules differ considerably. Molecules with higher velocities overcome forces of surface tension and are evaporated bringing away a part of energy, which – at condensation – can be transferred to a body with higher temperature than the temperature, which the body of its evaporation had. As we see, this natural real phenomenon is not consistent with the essence of the second law of thermodynamics but it is well consistent with the survival law. Without this substance cycling, neither biosphere evolution nor its functioning is possible. The cycling runs in line with the main laws of living and inorganic nature, which are the recently discovered survival law, the second law of thermodynamics (being opposite in their essences) and the general principle of the natural history – the energy extremality of self-organization and progressive evolution.

This natural mechanism of transfer of heat energy from bodies with lower temperature to bodies with higher temperature allows using the heat as renewable all-pervasive continuous widely available source of energy. Unfortunately, in the most prestigious edition in Russian on exergetic analysis of transformed energy [15], in common with many other editions on thermodynamics and exergetic analysis, it is asserted that the ambient heat does not contain exergy. The latter is anergy and it is impossible to use it as a source of energy. In the paper [15], the exergetic analysis is given of all known energy transformers, however, except for refrigerators and heat pumps, for which only energy-relied analysis is given and it states that the ambient heat does not contain exergy and it is anergy. In reality, the ambient heat possesses not the exergy of energy transformation but instead the exergy of transfer of heat energy from bodies with lower temperature to bodies with higher temperature.

If to take the statement on absence of exergy at ambient heat as being correct, then the exergetic power efficiency of a heat pump would be limited by measured ratio between <value of heat released by it for a certain time interval> and <exergy of the energy consumed by it for the same time interval>. Some producers of heat pumps act exactly this way; for example, this is typical for the company *Vitocal* [16] (Table 1).

Table 1 – Fragment of main technical specifications of the modern heat pump of Vitocal model (found on the Internet [16])

Vitocal 300 Type	Measurement unit	WW 240	WW 254	WW 268	WW 280
Nominal heat power	kW	52.0	73.2	90.2	106.8
Working point W10/W35* ¹ in line with EN 255	kW	42.8	60.0	74.0	87.8
Refrigeration capacity					
Consumed electric power	kW	9.2	13.2	16.2	19.0
Power efficiency		5.6	5.6	5.6	5.6

The value of the exergetic power efficiency of the pumps is limited without due account of the ambient heat exergy in connection with the existing concept that it is equal to zero. However the separate limiting of exergy of electric energy and exergy of ambient heat speaks for the fact that in this value of the power efficiency, the exergy of consumed by the pump electric energy makes only around 11%, while the rest component of transformer's power efficiency equal to 89 % is provided by the exergy of the ambient heat transfer. The exergy of the transfer of the ambient heat is high. It is especially so at use (in transformers) of working body with a low temperature of vaporescence. On every kW*h of energy consumed from mains,

these products must use 4.6 kW*h of exergy of environment heat transfer for premises heating-up. If to consider that the ambient heat does not contain exergy, the use efficiency of a primary energy-carrier by these energy transformers increases 4.6 times as compared to a direct electric heating-up. One of important advantages of these energy transformers consists in the fact that (as it is seen from the Table 1) at a change of pump unit capacity twice or thrice, its exergetic power efficiency is not subjected to changes.

6. Mono-thermal installation – assembly consisting of heat pump and low-temperature heat engine designed in the same principle and rotating electric generator

By the engineer from Kaliningrad A.C. Yayle, the mono-thermal installation [17] was constructed, which consists from a heat pump and a low-temperature heat engine relied on the principle of the heat pump rotating an electric generator working out the electric energy.

The emergence of the engine working on the "reverse Carnot cycle" is an indication of inadequacy of explanation of this phenomenon by a high energy-transforming ability of heat pumps and a confirmation of high efficiency of use of the phase transition as a working process.

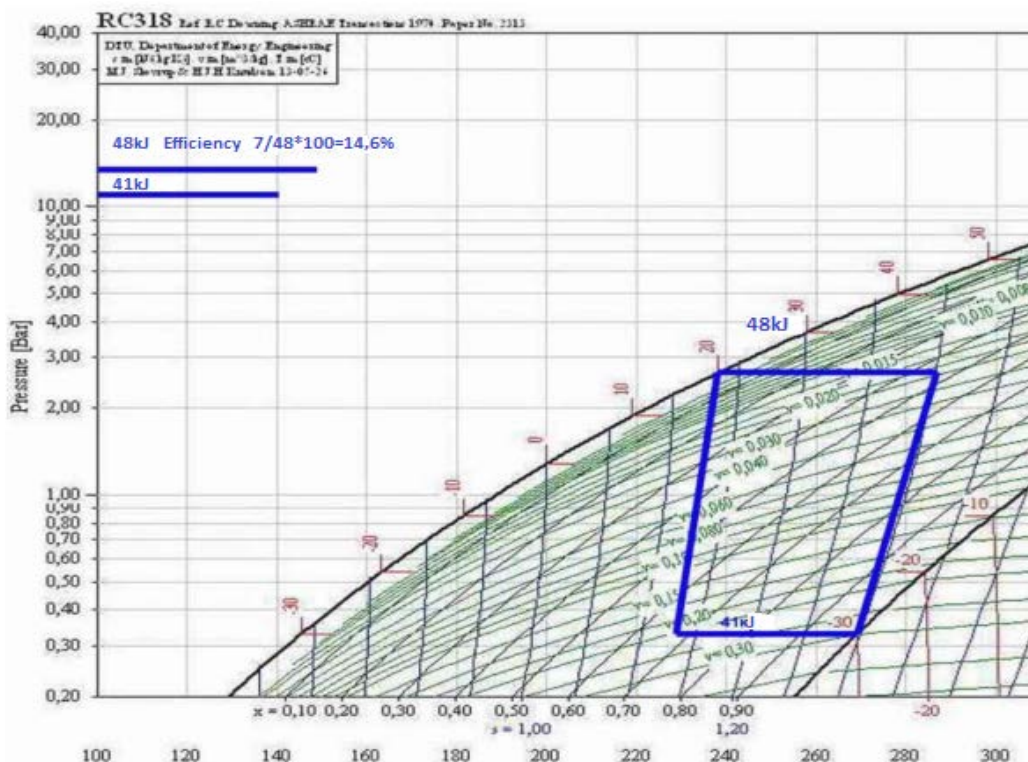


Figure 2 – Thermodynamic diagram and cycle of heat pump of mono-thermal installation (working body was octafluorocyclobutane RC318 (C₄F₈)) [17]

This installation works on evaporation–condensation of working body for extraction of heat exergy due to heat energy transfer from bodies with lower temperature to bodies with higher temperature. The heat pump and the heat engine work only based on use of this exergy. Only at the moment of switching on, the heat engine obtains electric energy from outside.

The work principle of the engine of the mono-thermal installation is the same as in refrigerating machines and heat pumps, i.e. as a working process it uses the self-organizing energy-saving phase transition <evaporation – condensation> of working body. As the heat carrier (working body) for the heat pump, the octafluorocyclobutane RC318 (C₄F₈) was chosen. There were built the thermodynamic diagram and the thermodynamic cycle of this working body, on which there was computed the thermodynamic (thermal) **power efficiency (=14,6%)** of the energy-saving phase transition <evaporation – condensation> (Fig. 2). Starting with this power efficiency value on the basis of the Carnot formula, it is possible to determine exergy of ambient heat for this working body and this thermodynamic cycle. For determination of exergetic power efficiency of this heat pump, it is needed to find out experimentally the value of heat released by it per a unit of exergy consumed by it. This power efficiency value serves as characteristics of a level (a measure) of perfection of the specific construction of the heat pump type. A quantity of constructive solutions on creation of any limited type of energy transformer can be endless. The value of the exergetic power efficiency is an indication of what level of perfection is reached by this construction of an energy transformer. This value must tend to 1.

At the accepted range of working temperatures (from –30°C to +20°C) for the heat engine of the mono-thermal installation and as working body, the trichlorofluoromethane R11 (CCl₃F) is used.

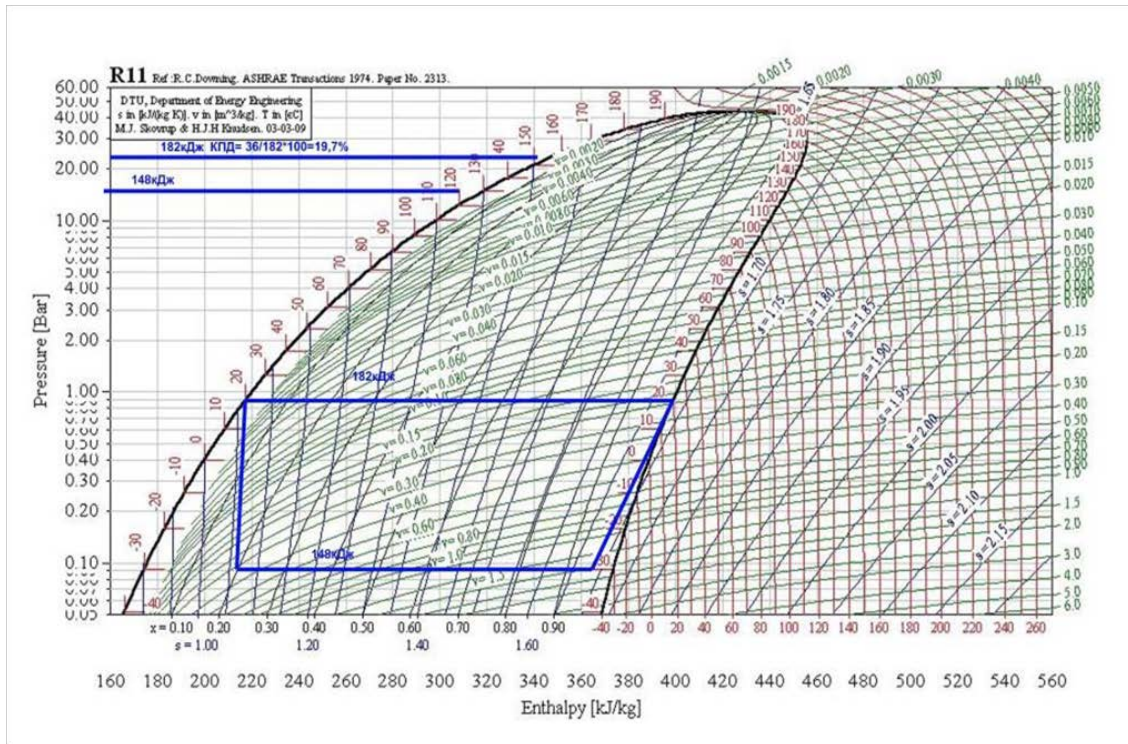


Figure 3 – Thermodynamic diagram and working cycle of heat engine of mono-thermal installation. (As working body, the trichlorofluoromethane – R11 (CCl₃F) is used)

Also, there were derived the thermodynamic diagram and the thermodynamic cycle with the same temperature range (from -30°C to +20°C). Based on them, there was computed the thermodynamic **power efficiency (=19,7%)** of the engine of the mono-thermal installation. (Fig. 3). In common with the case of the heat pump, based on the data of this Fig. 3, it is possible to determine the power efficiency and the exergy of ambient heat of the heat engine. By experimental determination of work or electric energy produced by this engine, it is possible to find out its exergetic power efficiency making use of the ratio between <obtained (measured) work quantity or electric energy> and <spend on them ambient heat exergy>. At the thermal gradient 500C in the case of the classical heat engine working on the "direct Carnot cycle", the thermodynamic power efficiency will be considerably less (approximately 9.1%). This speaks for incorrectness of the widely accepted in the thermodynamics statement that the thermal power efficiency does not depend on a working body. Exergy analysis is necessary to determine exergy efficiency. The experimental determination of the thermodynamic efficiency makes it possible to characterize two objects with one quantity: both the converter and the convertibility of the primary energy source. In the paper [17], it is reported that in 2000 in the thermodynamics, a breakthrough occurred. In USA by our compatriot A.I. Kaleena, there was constructed a water-ammoniac engine with prominent characteristics. It works at thermal gradient +180C and +800C.

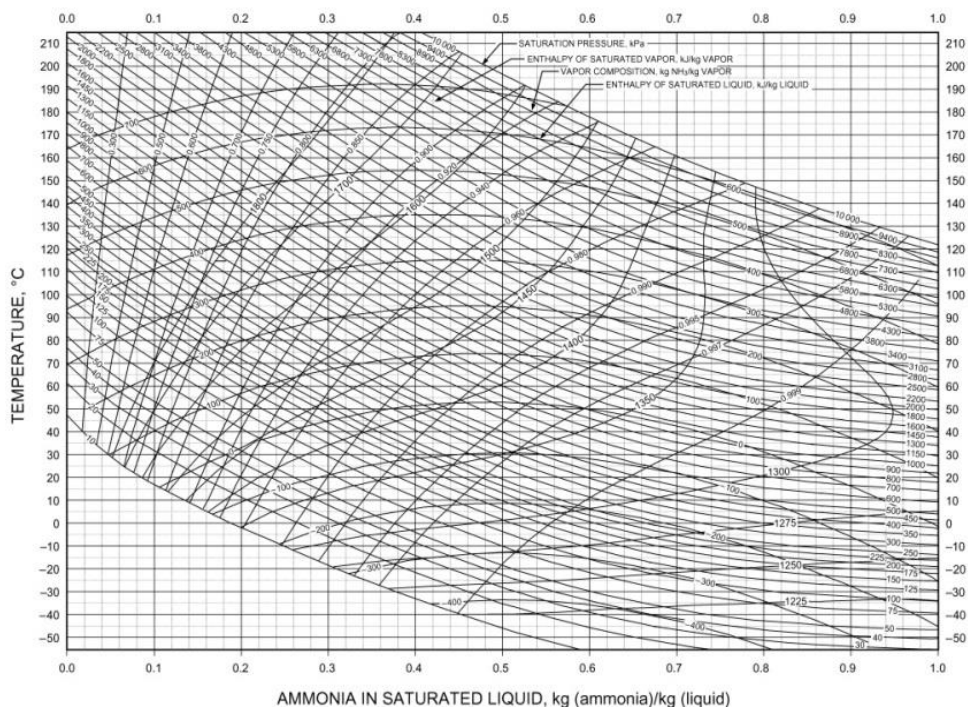


Figure 4 – Thermodynamic diagram of water-ammoniac working body of heat engine [17]

According to [17] knowledge, now on such heat engine, "all the geothermal energy engineering" works; such heat engine has the highest power efficiency as compared to other heat engines. Here is given the thermodynamic diagram of the water-ammoniac working body (Fig. 4). For construction of a developmental prototype, it is better to choose the water-ammoniac engine working on Kaleena cycle and the heat pump on the heat-carrier RC318–m. Based on these heat-carriers, two machines were created: the heat pump and the heat engine working on the "reverse Carnot cycle". Both machines are publically available in sale. As it is seen, exergy of ambient heat in every specific case is limited by thermodynamic properties of a working body and by thermodynamic cycle of energy transformer.

7. Rational management of natural resources is possible only based on taking laws of living nature and all natural history in account

Until recently, these laws were not known. The survival law and the second law of thermodynamics have energy-related nature. It is not a coincidence that the same essence is what characterizes also the general principle of natural history, the principle of energy extremality of self-organization and progressive evolution – which is seen from its definition [1], [5]. Energy-transforming technologies and technical devices make most negative impact on the natural environment and functioning of the biosphere. The most dangerous human-induced nature contaminant and biosphere destroyer is the heat emergence because of energy release by technological units into the natural environment; and the energy increases temperature of ambient heat. This impact on the biosphere is made by all energy transformers except for refrigerators, heat pumps and also low-temperature engines working on the similar principle.

The exergy of ambient heat transfer seems a great innovation of the nature and it has been not acknowledged and not used yet to a due extent. In the global biosphere-scale process of cycling of water and other matters (nitrogen, carbon, oxygen, etc.) being parts of living organisms, this energy-based mechanism is fundamental. However it works properly only when all ecosystems making together the biosphere are able functioning in normal way having the optimal proportion of three kinds of organisms: producents (autotroph plants), reducents (heterotroph organisms) and decomposers (organisms decomposing dead organics).

Prior to the discovery of the law of survival and the natural science of the party unity of knowledge, heat engines of this type, as well as heat pumps and refrigerators, did not have a reliable scientific basis. Obviously, this is the reason that in Russia there is still no proper production and use of heat pumps. Innovations in the field of thermodynamics and exergy analysis both in the Russian Federation [17] and abroad [18] are developing at the inventive level. The expansion of the use of exergy of heat transfer of the enviromental (phase transition) for use in thermal engines is a true development trend. In view of the understanding of the failure to explain the high energy-generating ability of heat pumps and refrigerators with the "Carnot reverse cycle", this term was not applied in both cases [17], [18].

8. Exergy of ambient heat transfer as main RES of energy engineering of future

The bulk decrease of fuel consumption in the world in the last 10–15 years had place mainly due to expansion of heat pumps for premises heating-up and obtainment of hot water. Now, the total volume of practical use of the heat pumps and refrigerating machines using the exergy of ambient heat transfer is commensurable with summary volume of all the rest RESs. Unfortunately, the development of this promising direction of energy engineering takes place mainly on the level of single inventions. As it is seen from the previous text, it is typical not only for Russia but also for USA.

The investigation [19] is considered to be an exclusion. It was conducted in Sweden by Professor P. Lanquist, the president of the Committee E2 of International Institute of Freezing. Within 35 years of work, he analyzed He showed what difficulties an important area of energy developing on an inventive and empirical basis can be fitted into.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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