STAGES OF DEVELOPMENT THE CONCEPT OF ENTROPY BY THE NONEQUILIBRIUM AND NONLINEAR THERMODYNAMICS

B. Draganov

An analysis of the concept of entropy - from phenomenological to statistical representation in the study of variational processes, discrete structures, fluctuations, thermal stability.

Entropy, equilibrium and non-equilibrium processes, reversibility, minimum entropy production, Gibbs energy, statistical thermodynamics, Boltzmann equation, entropy fluctuations, stability, dissipative structures.

Real progress is uneven, the evolution of an arbitrary state to a state of balance is a result of irreversible processes.

Exchanging energy or matter (or energy and material) of the system, eventually reaching the state of thermal equilibrium in which the systems become the same temperature. And so the equilibrium of the system is characterized by the equilibrium temperature distribution, and for them there are functions of state - the energy and entropy.

The purpose of research - to expand the concept of entropy and significance on the basis of modern thermodynamics. Questions nonequilibrium, nonlinear thermodynamics of dissipative structures.

Materials and methods of research.

Fundamentals of nonequilibrium thermodynamics

The evolution of an arbitrary state to an equilibrium state occurs as a result of irreversible processes. Temperature in all parts of the system in this state, it is the same.

However, a uniform temperature distribution is not one of those requirements, under which the entropy and energy of the system becomes completely defined. For non-equilibrium systems in which the temperature is not evenly distributed, but

locally well defined, we can introduce the density of the thermodynamic quantities (potentials) as energy and entropy.

General information about the statistical thermodynamics of Hamilton, the theory of ensembles

In classical mechanics, the state of a system of point particles are usually described coordinates and momenta. Particularly important role played by the energy of the system, written in these variables.

The basic idea of introducing the concept of the ensemble is that instead of a dynamical system, as is customary in the Hamiltonian system, consider the set of systems that meet the same Hamiltonian. Gibbs ensemble can be represented as a set of points in phase space. Note that the Hamiltonian function is used in the classical calculus of variations for representing the Euler equations of motion of mechanical systems in canonical form.

Boltzmann equation

Analyzing the relationship between the microscopic and macroscopic behavior among the laws of thermodynamics Boltzmann introduced his famous relation between the entropy and probability.

Further development of the various branches of science (statistical physics, information theory, and others.) Confirm the depth of knowledge of nature, which is inherent in the Boltzmann equation.

The concept of entropy can be applied to thermodynamic equilibrium, if the deviation from thermodynamic equilibrium are small and can introduce the concept of local thermodynamic equilibrium in small but still macroscopic quantities. In general, the entropy of the system is the sum of the entropies of its parts in local equilibrium.

Thermodynamics of nonequilibrium processes allows for a more detailed study of the process of increasing entropy and calculate the amount of entropy produced per unit volume of time due to deviations from thermodynamic equilibrium.

Entropy fluctuations

One of the most profound consequences of non-equilibrium thermodynamics is manifested in the duality of the irreversible process: as the destroyer of order near

equilibrium, and as the founder of the order of far from equilibrium. For systems far from equilibrium are not met the general principles of extreme predicting the state to which the transition of the system. In the absence of the principle of extrema uniquely predictive state to which seeks nonequilibrium system is fundamental, property of non-equilibrium systems. In contrast to equilibrium systems that convert to a state of minimum free energy nonequilibrium systems can develop unpredictably: their condition is not always uniquely determined by macroscopic equations. This stems from the fact that under the same set of conditions, the non-equilibrium system mo¬zhet switch to different states. The reason for this may be fluctuations, small inhomogeneities, defects or other random factors. Which of a particular system will, in general, can not be predicted. The new state is achieved in this way are often "ordered states" that have space-time organization. The fundamental property of non-equilibrium; systems lies in the ability to move into an ordered state as a result of fluctuations - t. e. to carry out the "order through fluctuations" [4-7].

In nonequilibrium systems by chemical reaction and diffusion may be fluctuations in the concentration and spatial structures; zakry¬toy same system in the same dissipative processes blur the heterogeneity and bring the system to a homogeneous, time-independent equilibrium. Since the emergence and maintenance of organized neravnovesnyh states is due to dissipative processes, these states are called dissipative structures.

The concept of dissipative structures and order through fluctuations uchity¬vaet basic properties of nonequilibrium order.

The entropy of heat and mass transfer processes in porous media

Generation of entropy in the flow of fluid through a porous medium is studied TV Morozyuk [10]. Here are the main provisions contained in this work.

The problem of entropy generation in energy conversion systems was analyzed A. Bezhanov [5, 6]. The results obtained allowed to solve the problem of minimizing a heat exchange process [7], as well as optimizing the economic performance [8].

This method is widely used for the analysis of heat and mass transfer processes in porous media [9-15].

Conclusion

Entropy is a measure of the energy loss (irreversibility) phenomena taking place in many areas of production: heat and mass transfer, the physico-chemical, disperse structures, fluctuations etc. In the future, with the advent of new technical solutions entropy, no doubt, will play the role of valuation measure of excellence in relation to the energy of the investigated phenomena.