



Lecture No. 80

Czech Society for Mechanics and Institute of Thermomechanics, CAS

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within the lecture series **Institute of Thermomechanics Seminar**

Properties of open thermodynamic systems as the consequence of their stability

given by

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The presented concept deals with production of entropy generated by the nonequilibrium processes in consequence of the mass and energy transfer. Often used concept of endoreversible thermodynamics is based on non-realistic conjecture that the entire entropy production is realized at the system boundary. In this contribution, the open system in the thermodynamically non-equilibrium state is assumed. Production of entropy is generated due to the non-equilibrium processes accompanied by the energy conversion. The non-equilibrium steady state is maintained by a negative entropy flux. The stability conditions of the state with the minimum of entropy production are used to replace the endoreversibility concept.

This theory is applied to three different open non-equilibrium systems.

i) Efficiency of thermal machines and chemical reactors.

Hydrogen fuel cell with polymer electrolyte membrane are studied in details. The transport coefficients for reactants inlet, i.e. hydrogen and air, and for the products outlet, i.e. water, are connected with the actual electric efficiency. The calculated efficiency qualitatively and quantitatively corresponds to the experimentally obtained values. The further research shall focus on the relation of the parameters characterizing the membrane and transport of reactants and products to the power output.

ii) Energetic limitations of population growth.

Entropy production is characterized by general form of chemical reaction based on the mass action law. This law is usable for description of dynamics of population biology, e.g. cells, species. Moreover, this law can be even used to study dynamics of ecological systems. The reproduction process is spontaneous process with increase of entropy. The entropy increase is compensated by the negative entropy flux from the Sun. From the thermodynamic point of view, the sex reproduction is more advantageous as the cellular division because of it is reached by the lower Gibbs free enthalpy. This is probably the reason why sex reproduction is evolutionarily more advantageous.

iii) Dynamics of ecological system with migration.

Influence of reproduction and migration dynamics is evident on example of two competitive ecological systems (in general two auto catalytic reactions) of type predator and prey. The migration decreases the frequency of dynamical state of system. Due the migration this dynamical state can change to the stationary state, when time period is high enough. In principle, it is a diffusion reaction system in which a stationary spatial change of concentrations can occur. An example may be the presence of colored stripes on the body of some animals, such as cats, some fish, hornets, and the like.

**The lecture will be held on Wednesday, December 4, 2019 at 10:00 in the building
of the Institute of Thermomechanics (lecture room B), Dolejškova 5, 182 00 Prague 8**

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