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Endoreversible Thermodynamics

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We are living in a world full of heat engines, refrigerators and other energy transformation devices. Even life can be regarded as special form of energy transformation. The understanding of these devices and of the processes they perform have been central to our technological development in the past and will be of equally great importance for our future development. Equilibrium thermodynamics as it evolved during the19th century has provided a macroscopic theory for the description of these thermodynamic systems. However, it put its focus more on the states rather than on the processes occuring between the states. In doing so it became a powerful theory, but the prize to be paid till today is that more often than not processes are understood as a (quasi-static) sequence of equilibria neglecting irreversibilities. This idea of reversible processes is however at variance with the experience that in everyday live the processes occuring are not reversible, and - more important - are not designed to be reversible, because the desired finite rates for the energy transformation require finite and thus irreversible fluxes.

During the years there have been a number of attempts in engineering and physics to overcome this view, and one of the non-equilibrium thermodynamic fields, which developed during the last 30 years, has been labeled endoreversible thermodynamics. The basic idea of the field is to describe a non-equilibrium system as a collection of equilibrium systems, such that all the irreversibilities occuring in a process are due to the interaction between those subsystems. This approach is certainly supported by the observation that in our surroundings we can indeed find subsystems which can to a good approximation be treated as equilibrium systems. In addition, all the power of conventional equilibrium thermodynamics can be used for the description of the subsystems, while at the same time dissipative processes are no longer neglected. Most of the work published in the field of endoreversible thermodynamics has been focused on determining performance predictions for heat engines and other energy transformation devices which include the necessary irreversibilities caused by finite transformation rates. In this presentation a general framework for the endoreversible description of a system is presented, followed by a discussion of the performance of such systems.

References

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