Review of: "Tailoring the First Law of Thermodynamics for Convective Flows"

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Potential competing interests: No potential competing interests to declare.

The first law of thermodynamics is essentially the statement of the principle of the conservation of energy, and hence the variation in energy of the system is equal to the amount of energy that the system receives from its environment. If a thermodynamic system has a fluid-dynamic description, the variation of energy is caused by the flow of energy described by the corresponding flux. We can find various balance laws in textbooks on fluid dynamics and continuum mechanics. It is worth consulting

C. Dafermos, Hyperbolic Conservation Laws in Continuum Physics (Grundlehren der mathematischen Wissenschaften, 325), 4th ed., Springer, 2018

The present author has obtained a form of balance law that is quite similar to the equilibrium thermodynamic first law. Reviewers appreciate it very much.

In the reviewer's opinion, the most important energy exchange is the heat transfer, which is controlled by the temperature. Thus, the reviewer thinks it essential to introduce or define the temperature at every space-time point. Let us consider the ideal gas. For the equilibrium ideal gas, the temperature T is defined by the equation of state pV = RT. However, in a non-equilibrium gas, the equation p(x,t)V(x,t) = RT(x,t) looks true. This equation is actually true by assuming the thermodynamic system attains the "local thermodynamic equilibrium (LTE)," which means one assumes thermodynamic equilibrium in some infinitesimally small neighbourhood of every space-time point (x,t). Thus, the reviewer thinks it essential to assume the system attains LTE in order to go forward.