# Explicit relations for the entropy production density for fluids and solids and its dependence on ordinary material parameters

by
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The entropy inequality, also commonly known as the 2nd Law of Thermodynamics, is commonly used in modern continuum theory for reducing the possible form of constitutive equations. However, in this talk we aim at a different direction: We want to use the entropy inequality in order to determine the local degree of irreversibility in a thermodynamic process as a function of commonly known material parameters, such as shear modulus, yield stress, heat conductivity, etc.

Clearly, for this purpose a boundary value problem has to be stated and the constitutive equations of the material investigated need to be known. We will focus on two constitutive models: First, the Navier-Stokes fluid and, second, the modified Bingham fluid model. The latter is particularly interesting since it allows finding a transition to plastifying solids and how their degree of irreversibility is driven by yield stress and hardening parameters. The boundary value problem which we consider is that of a stationary channel flow between plates, driven by an axial pressure gradient as well as by plate velocity.

This way *analytical* solutions for the velocity profile can be found, even for a limit case of the modified Bingham fluid. The general case, however, requires a simple numerical solution resulting from a shooting technique applied to the relevant ODE. We will show analytical as well as numerical solutions for both the velocity as well as the temperature profile in the channel. It is important to note that isothermal conditions are impossible since the shear between fluid layers leads to dissipation and thus to the creation of heat. Based on the expressions for the velocity and temperature profiles we will finally determine, analytically as well as numerically, the entropy production rate and discuss its behavior in terms of material parameters. The talk will end with an outlook into the extension of this method to plastifying solids.