Some Insights into Properties and Processes with Balance Equations for Mass, Energy, and Entropy

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Balance equations of the Laws of Thermodynamics connect heat, work, and material flows, plus stream properties, in proposed or existing processes. The results are reliable with accurate models for the conceptual properties of enthalpy and entropy from the measurables of temperature, pressure, and composition. The approach fixes a process configuration and computes values of two unspecified flows or properties. One analysis determines a constraint on one stream and the irreversibility, i.e., entropy generation, of a process. Another determines two conditions of a process with a specified entropy generation, such as for reversibility, i.e., zero entropy generation, giving minimum energy requirements. Results can be used to focus on locations and impacts of irreversibility in order to improve efficiency. Also the accuracy of property models can be checked by comparing the sum of surroundings energy flows and entropy productions of individual process sections with the analysis of the overall system.

The lecture will summarize the fundamental equations, illustrate several cases from simple to complex process systems, and suggest extensions.