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''CLEANER PRODUCTION INITIATIVES AND CHALLENGES FOR A SUSTAINABLE WORLD''

From Modern Thermodynamics to How Nature Works – a View of Emergent Paradigms Associated with Sustainability

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Abstract

The importance of the second law of thermodynamics, already called the most metaphysical of all laws of nature, as key to understand the questions of ecology and sustainability is discussed, as well as the a fast paced conceptual evolution that gained momentum in the last 50 years , changing our view of Nature. Classical thermodynamics, is associated with the tendency to disorganization, while nonlinear irreversible thermodynamics, introduces the concept of emerging ordered dissipative structures, a necessary tool to deal with the nature of living beings and its social, economic and ecological aggregates. Most introductory texts in thermodynamics are limited in scope , restricting the expositions to the study of equilibrium systems- meaning the study of idealized, infinitely slow process, hardly a situation encountered by the professional life, and far away from how nature works, as an coherent and complex aggregate of dissipative processes. Dissipative structures are living (i.e. amoeba and humans), and non-living (i.e. tornadoes, hurricanes, the gulfstream), or composed by non-living and living, like economies, factories, social structures. The author's teaching experience gives evidence that undergraduate students are ill prepared for the discovery and fascination of how nature works, and consequently striving for sustainability. Systems of major interest to the issue of sustainability are open, coherent, purposive, and irreversible. Irreversible thermodynamics is presented as an element for the understanding and unification of a wide range of disciplines needed by the student, but still subjected to a fragmentation of a somewhat bureaucratic nature. This integration benefited from the enormous development of computers, and its use in the study, as an example, of nonlinear dynamics system with wide applications in various fields including engineering, biology, ecology, economics, and sociology.

Keywords: *Thermodynamics, open systems, non-linear dynamics, sustainability*