English language appears in Shakespeare where he mockingly and despairingly talks of the "engineer hoist on his own petard." Regulation is a must to ensure the safety of the planet from a technology grown wild. Progress involves failure and large scale projects can lead to devastatingly large losses of life and limb unless strictly regulated. Adams covers the "painful inevitability" of this in the penultimate chapter.

In the last chapter, Adams gazes into the crystal ball to speculate about the future. He suggests how the impending changes will influence the professional lives of engineers to come. "Increasingly complex technology and social problems will result in more constraints and requirements and require stronger interaction between the community of engineers and the larger society." The book ends with a very valuable bibliography of sources and suggested reading, arranged chapter-wise.

James L Adams is a Professor in the Department of Values, Technology, Science and Society at Stanford University. The book reflects all these values, using, as the quotation from Peter Likins on the blurb puts it, an "engaging, personal style of a letter to an young friend considering an engineering career." Engineers as people, if not as poets, is the picture that is painted in this enlightening tour.

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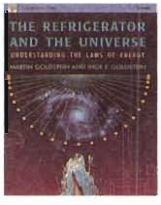
Thermodynamics: An Exposition for the Layman

R Srinivasan



The Refrigerator and the Universe
Understanding the Laws of Energy
Martin Goldstein and Inge F Goldstein
Universities Press (India) Limited, 1997
pp.443, Rs 225/-

Thermodynamics has a hoary past. The laws of thermodynamics have stood the test of time and have remained unchanged even after the revolutionary developments in physics with the advent of quantum mechanics and special theory of relativity. Thermodynamics covers processes resulting in the interconversion of heat and work. It therefore has a wide range of applicability from heat engines to chemical reactions to black holes. Thermodynamics deals with the relationships between macroscopic properties such as energy, entropy and work. It does not depend on the microscopic mechanisms responsible for such properties. This is one of the reasons for its success and is also a cause for its limitation. While thermodynamics can say that a chemical reaction is possible it cannot state with certainty that it will occur.

In teaching thermodynamics at the undergraduate level, one finds it very difficult to put across the concept of entropy successfully to the student. In the calculation of entropy one must always limit oneself to reversible processes. But entropy is a state variable and hence independent of the path followed to reach the state, even if the path is irreversible. It is this idea that the student finds difficult to comprehend. The second law also has the consequence that only processes in which the total entropy of the system increases or stays constant are possible processes. Here the emphasis is on the total entropy of the system and not the entropy of its constituents. What constitutes the total system is also a matter of confusion and often leads to situations in which one sees an apparent contradiction to the second law.

In this book the authors aim to trace the development of thermodynamics from its early days of caloric theory to its application to the current ideas of an expanding universe in astrophysics. It is a very daunting task to take on such a wide sweep and it is more challenging to do this without the aid of mathematics. It is one of the special features of the book that even the elementary mathematical equations are relegated to an appendix and an attempt is made to present the basic concepts in simple language understandable to a layman. The authors have succeeded eminently in this task.

The concepts of energy, work and temperature in the early chapters of the book are developed from simple every day examples which will appeal to a general reader. The authors then go on to point out the equivalence of mechanical and heat energies and the experiments of Joule which proved the death knell for the early caloric theory of heat. They then introduce the kinetic theory and present a microscopic picture of heat energy as the average kinetic energy of the atoms.

The concept of entropy is introduced as a development of experience with early steam engines. A heat engine always needs a hot and a cold reservoir for its operation and one could never convert all the heat into mechanical work. The concept of reversible and irreversible paths by which a change of state can occur is explained lucidly. It is pointed out that it will not be possible to get a direct proof of the second law of thermodynamics and one can only deduce certain consequences of the law which can be verified, such as the lowering of the melting point of ice with pressure.

The connection between entropy and disorder expounded in Chapter 7 is one of the clearest expositions that I have come across. The concepts of micro- and macro-states are introduced lucidly and the connection between entropy and the number 'W' of micro-states associated with a definite macro-state is explained very clearly. I would specially recommend teachers at the undergraduate level to use such a presentation in their classes.

The gross failure of the equipartition theorem in explaining black body radiation is then pointed out. This leads to the genesis of the quantum theory and the authors again explain, with the aid of a simple diagram, how the average energy of a linear harmonic oscillator will fall below the value of kT when the separation of energy levels is large compared to kT.

The applicability of thermodynamics to chemical reactions and to living systems forms the subject matter of Chapters 11 and 12. The argument of creationists that the second law is violated in the evolution of order in going from single celled to complex living organisms is refuted reasonably effectively.

Kelvin's deduction of the age of the earth from the rate at which the earth cooled and the controversy it generated with the geological evidence is discussed in some detail in Chapter 13. The controversy was resolved with the discovery of radioactivity and the realisation that this provided a source of heat not included in Kelvin's calculations. The last few chapters deal with Quantum Mechanics and the third law of thermodynamics, and the applicability of the first and second laws of thermodynamics to an expanding universe. The reader is taken on brief excursions through the basics of quantum mechanics, special and general theories of relativity. In an expanding universe the first law breaks down. But the authors conclude on the basis of existing evidence that the second law is still valid.

I found reading this book very enjoyable. I would suggest that every college library should acquire a copy as it will help the undergraduate science student get a better grasp of thermodynamics. It will also provide a serious non-science student with enough material to ponder on the power, the sweep and the limitations of one of the most long-standing and successful theories of science.

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Why did the chickens cross the road?

The Sphinx: You tell me.

Joseph Stalin:
It was clearly a conspiracy. Take all the chickens out and shoot them. At Once!

Thomas de Torquemada:
Give me ten minutes with the chicken and I'll find out.

From: *Internet*