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Book Review

Block by Block the Historical and Theoretical Foundations of Thermodynamics, by Robert T. Hanlon, Oxford University Press, 2020. ISBN: 978-0-19-885155-4.

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This book entitled *Block by Block the Historical and Theoretical Foundations of Thermodynamics* provides a solid fundamental foundation interlaced among the three different worlds of academicians, practitioners, and historians. Most thermodynamic books focus only on problem solving using some laws and equations but lack in deep understanding of the concepts that are central to thermodynamics. This book takes the approach of providing inspiration, confidence, and creativity to students for ultimately solving a whole range of thermodynamic problems faced by chemical, mechanical, aerospace, and environmental engineers in academia and industry. It is easy to read, providing meaningful information to someone with little background in thermodynamics. Historical understanding combined with scientific understanding truly helps to enhance one's understanding of thermodynamics. This 646-page book with over 11 pages of references is much different from most books on thermodynamics. The book is written in simple plain text with no equations, solved problems, or example problems at the end of a section or a chapter. The book focuses primarily on history perspectives, which are mostly omitted in thermodynamic books. It shares how the concepts and terminologies used today were elevated from their historical origins. These when combined with good scientific understanding enhance a good grasp of thermodynamics. The book has four parts. The first part is on Big Bang and the synthesis of the elements in the stars. The macroscopic thermodynamics is governed by the microscopic atomic world. The second part is on the atoms that can be thought of as hard spheres that attract and repel each other. The third part is on energy and conservation laws since one always has some cause behind an effect. The last part of the book is on entropy and the laws of thermodynamics. A broader discussion of the scientific method is provided as to how it appears and how it should be conducted. Contributions made are, in general, on similar processes with gathered data from some set of hypotheses to provide conclusions or to test against the reality to support the proposed hypothesis.

The book is for curious minds and as such can be used by anyone who has taken high school science. It is also useful for those who have taken introductory college-level thermodynamics as the examples given here do involve historical thermodynamics. It can also be an excellent reference book for history students in addition to engineering students. This is not a textbook for use in a classroom but rather supplementary reading to enhance fundamental understanding on how and why things work in different types of energy conversion processes, engines, and power systems. The physical properties of matter are well covered in other textbooks with equations and the meaning of those equations. This book provides a good solid foundation for fundamental understanding on which to build solutions. Many examples are given that give some fundamental insights into the complex thermodynamic problems faced by engineers and scientists today to solve the problems. As an example, when Carnot looked at the steam engine, it was not that such a machine worked, but rather how good it could be? The theory was not needed to commercialize the steam engine but rather for determining the maximum performance and further guide the technology development. The empiricist engineers could not wait on theory development to guide them. In the early 1800, a typical coal furnace operated at well over 1000 ^{o}C, but the saturated steam temperature in the best of steam engines could be only 150 ^{o}C. This large temperature difference can be thought of as some kind of loss, but no approach existed to quantifying this loss or quantifying the engine efficiency. Carnot focused on temperature to calculate the efficiency by devising an ideal process to convert heat into maximum work possible. This required creation of new ideas and concepts that later became core to the rising science of thermodynamics. These ideas and concepts included the importance of temperature, closed cycle process of a heat engine, entropy, and Clapeyron and Clausius–Clapeyron equations. The caloric has many properties that were later assigned as heat. However, to Carnot, the two were the same, as taken from his note saying that "they employ these two expressions indifferently." The critical statement to this statement became apparent later since the property that could not be assigned to heat concerned conservation so that in Carnot equation, calorie was conserved, while in Clausius equation, the heat was consumed.

There are many examples of such clarifications and substantiations in this book that makes it unique and more useful for further understanding in enriching the theoretical foundation of thermodynamics. It provides good insights on steam engine practice: from ideas to practice to theory that encompasses energy theory, joule heat-work, entropy, first and second law of thermodynamics, and statistical theory of gases and statistical mechanics. There are many texts that provide the governing equations for the various quantities used, but this book makes a very good attempt to connect all the pieces together from the historical perspectives by giving many examples. Many books are available that provide the relationships between various quantities and properties but not the history and how and when it was evolved. This book provides a detailed history, and it is easy to read. One does not have to be an engineer or a scientist to grasp the information presented here. This book is for a curious individual with a desire to dig deep into the origin for seeking comprehensive information on the theoretical foundation of thermodynamics.

This well-written book is factual and comprehensive. There is no other book that provides so much details and insights as this book. It is easy to read, and one does not need much background knowledge and details on the subject to understand the material presented here. This historical foundation book on thermodynamics should be of great value to undergraduate and graduate students as additional reading material while taking their thermodynamic course or for leisurely reading after taking the course on thermodynamics. It is also useful for practicing engineers and scientists for their quest on how the engines were

all evolved and how the different caloric theory, puzzling part of heat, energy, and its conservation helped to enrich our understanding of thermodynamics. Overall, I value the material presented here and should be of great interest to a wide range of engineers, scientists, and students enrolled in engineering as well as history major.