Thermodynamics: foundations and applications
Elias P. Gyftopoulos and G.P. Beretta
Macmillan Publishing Co., New York
1990, 680 pp.

Thermodynamics is a science that has been taught in universities for a century or more all over the world. An attempt to explain its apparently simple rules has been tried quite frequently and it is not surprising that each year sees another, new undertaking.

This hardbacked, elegant and ponderous work, has been written by Professor Gyftopoulos and Professor Beretta. Professor Gyftopoulos has been teaching the science of thermodynamics at MIT for many years, and is also the author of the entry 'Thermodynamics' in the latest edition of the *Encyclopedia Britannica.* Professor Beretta, who is an Associate Professor of Applied Physics ('Fisica Tecnica') at Brescia University, Department of Engineering, graduated at the Polytechnic School of Milano in Nuclear Engineering and was one of my pupils before becoming an associate of Professor Gyftopoulos, under whose lead he has been teaching thermodynamics at MIT for several years.

This volume is also remarkable for both its extent (about 650 pages) and accuracy. Its size is further justified by the numerous problems it tackles – some of which are treated in depth, and many of which are left to be solved by the students at the end of each chapter. There are literally hundreds of these problems and even a specialist would have difficulties in finding the solution of some of them. It should be emphasized, however, that with few exceptions, their conception is very lucid.

From a didactic point of view, additional excellence has been achieved through the structure of the text. This is very important because of the new vocational degree ('University Diploma') courses to be activated in Italy for the academic year 1992–1993 in many Schools of Engineering. Among the 31 chapters which the book contains, it is possible to select 14 of them, as suggested by the authors, that will, by themselves, constitute a course in elementary thermodynamics (including the thermodynamic cycles pertaining to the main thermal machinery) that is no longer than 250 pages. The addition of a further 5 chapters converts the course into one of 'advanced thermodynamics', without losing its elementary peculiarity. Extending the course to include the remaining chapters allows it to be transformed into one of the most advanced courses in Thermodynamics for graduate students. Such an organized structure allows the book to provide tuition up to University Degree standard. The same concept may be applied to physical-chemistry courses in the graduation to Chemical Engineering.

The conceptual layout of the book is very strict regarding the definitions, quantities and the enunciation of principles. In particular, the First and Second Laws of Thermodynamics are introduced in their widest interpretation and, from them, the definition of energy and its conservation, as well as the definition of entropy and its non-negativeness, follow as straightforward corollaries. It may be difficult to accept the existence of 'non-equilibrium states', but this depends on the stated definitions. Once they have been properly specified, everything goes more smoothly. Further, it should be emphasized that the concept of entropy can be extended for any system, including one with only a single degree of freedom and for any state, including a non-equilibrium state. Of course, it is only for stable equilibrium states that we can write a fundamental equation whose derivatives have a meaning only for those states: temperature, pressure, and chemical potentials.

The subject encompasses the so-called simple systems, but it takes into consideration not only the perfect gases and ideal solutions but also gases and solutions that are far from ideal. The last 100 pages are devoted to systems in which chemical interactions take place. In particular, this section discusses combustion, together with its unavoidable and associated increase in entropy. The book purposely omits the theory of fluctuations and statistical mechanics. This is a deliberate omission to enable thermodynamics to be taught on the basis of a few principles and not on mechanical models, which, together with their own merits, also carry the flaw of running into serious troubles on the enigmatic bi-directionality of time – something that thermodynamics denies.

Some remarks: in a few, very few, exercises to which the answer is given at the end, the authors occasionally indulge in loaded questions, to the discomfort of the learner. On combustion, I would have preferred to have seen some additional pages on the reaction rates of the components taking part in the reaction. This would have avoided such a compressed version of very difficult theories and would have imbued the students with some idea of the order of magnitude of the times required for chemical equilibrium to be attained – quantities that prospective engineers cannot ignore – in association with the transit or permanence time of reactants and reaction products in burners, reaction chambers of internal combustion engines (both spark and diesel), post-combustors and other paraphernalia and equipment.

In reviewing this work I decided not to react like a time-pressured referee who blesses a book he has not really read with eloquent phrases and very little criticism. I gave this text my complete attention and I suggest that it should be used in all Italian engineering faculties and not only for the degree in Mechanical Engineering. Some parts of the book can even be adopted for use in Further Education courses and the volume could usefully be located in many professional agencies. In the home, it would give added prestige to any owner.

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