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Book Review

Anatoly I. Burshtein: Introduction to Thermodynamics and Kinetic Theory of Matter
John Wiley & Sons, Inc., New York, 1996, xiii+336 pages

The book serves as an introductory study and is addressed to a broad audience. Its main purpose is to help with the prediction of different properties of matter on the basis of molecular structure. It is a fundamental work for the start of research work, leading from observations and facts to general conclusions. Although it is based on courses of lectures held by the author, it is recommended not only for students, but also for scientists and engineers. It provides a reasonable balance between a very simplified and a too detailed discussion.

It is suitable for both a preliminary acquaintance with thermodynamics and the kinetic theory of matter and for their advanced study. For scientists intending to work on the field in question, it is not recommended to start with a more detailed textbook. The book is equally useful for those not closely associated with thermodynamics and kinetic theory and also for those trying to understand recent papers. It starts from clear facts and arrives at the equations occurring in the literature.

As concerns the contents in detail: Section 1.10 is a good summary of the basic ideas of statistical thermodynamics. It seems to be profitable to recall the orthometric curve, which is a useful but not widespread concept. Section 3.4 is a very important part, dealing with real crystals. The behaviour of gases and solids is dealt with on a common basis in order to allow a better understanding of both. Equations of state are derived not only for gases, but also for solids and liquids. This is useful for a discussion of the liquid state, starting from the properties of solids. The purely quantum photon gas is discussed in detail; this is one advantage of the book, since this field is not too well known. Another merit of the book is that the quasithermodynamics of inhomogeneous media is presented in it for the first time. The new concept of 'pseudo ideal state' (page 45), which is currently becoming widespread, is emphasized and clearly explained.

Chapter 4 is perhaps the most interesting part of the book. It is an introduction to the field of equations of state. Within this, it deals with modern theories such as the decomposition of equations, now coming more and more into the foreground. Section 4.2 should have contained the most widely-used equation of state of hard bodies, the Carnahan-Starling equation (Carnahan, N. F., Starling, K. E.: J. Chem. Phys. 51, 635 ([1969]). It should have been mentioned that his equation is an empirical combination of the pressure and compressibility equations: the weighted mean of the two terms of Equation 4.2.17, using the weighting factors 2/3 and 1/3, respectively, which is now regarded as the best analytical expression for the equation of state of a hard sphere fluid; it is well known and cited widely.

Chapter 5 deals with familiar topics, and it is impressive how facts are introduced to lead up to the most important thermodynamic relations.

It is a pity that the book does not contain a list of notations with explanations. The number of bibliographical data is scanty in comparison with the wide field dealt with.

Finally, it must be emphasized that the aim of the book and the method of discussion make it suitable for wide-ranging use by students, scientists and engineers.

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Patrick Takahashi & Andrew Trenka:
Ocean Thermal Energy Conversion
John Wiley & Sons, Chichester-New York-Brisbane-Toronto-Singapore, 1996

This book on renewable energies belongs in the UNESCO Energy Engineering Series. As F Mayor, Director-General of UNESCO, states in the foreword, 'the series as a whole is a cooperative venture involving many institutions working together..... to promote awareness of the environmental, cultural, economic, and social dimensions of renewable energy issues'. The topic is basically ocean energy utilization. Each of the four chapters of the book begins with a statement of the aim of the chapter and the objectives concerning the desired improvements in the reader's knowledge of the topic. The chapters end with self-assessment questions and answers.

Chapter 1 is dedicated to, first, the possibilities inherent in ocean energy in general and, second, the advantages of ocean thermal energy conversion (OTEC). The history, the present situation and the essentials about OTEC are outlined. The basic idea of OTEC is that the temperature difference between the cold seawater of the deep and the warm surface water can be used as the two heat tanks of a thermodynamic cycle.

Three variants of OTEC based on the above idea are presented with the aid of schematics. The first variant is the closed-cycle OTEC system, which is essentially a Rankine cycle with a refrigerant as the working fluid. The open-cycle OTEC system uses the warm surface seawater itself as the working fluid: the evaporation is produced by lowering the pressure by a vacuum pump to the point where the warm seawater boils at ambient temperature. The steam produced drives a low-pressure turbine to generate electricity; it is then condensed in a heat exchanger cooled by deep ocean water, producing desalinated water as a byproduct. The hybrid-cycle OTEC system is a combination of the above two.

The Japanese Government has for some years been supporting the design of a multiple-product OTEC (MP-OTEC) system. Besides electricity generation, MP-OTEC also provides desalinated water, air conditioning and refrigeration, and permits mariculture and agriculture operations in an integrated system. This development is important for island nations to cover their needs for energy, water and food. The Pacific International Center for High Technology Research (USA) has investigated the locations of existing MP-OTEC systems. They have found high potentials on eight Pacific islands.

Electrical power generation with performances of about 1 MW can be cost-competitive in remote, oil-dependent Pacific island contries. The long-run leveled price of energy from such a plant is estimated as \$0.11 to \$0.19/kWh. This means significant savings as compared to the price of \$0.16 to \$0.44/kWh of electricity on an isolated island.

Fresh water production of approximately 4750 m^3/day can be delivered from a 1-MW open or hybrid OTEC plant. The desalinated water from an OTEC plant is actually purer than the water provided by municipal water systems.

Air-conditioning and refrigeration with cold seawater is possible either directly through space heat exchangers or by cooling the refrigerant of a conventional refrigerating cycle. The cost can be about 25% of the operating cost of a conventional air-conditioning system. The pay-back period for the capital investment is estimated to be four years or less.

Coldwater pipes with a length of several hundred meters can be used for aquaculture and mariculture. Several kinds of fish are cultured, as are edible seaweed and algae. Coldwater agriculture is viable by burying coldwater pipes in the ground, which creates cool water growing conditions not found in tropical environments. The system also yields drip irrigation by atmospheric condensation on the pipes.

The future will no doubt be tied to multipurpose applications yielding all the above benefits and others. The near future is said to be that of land-based integrated OTEC systems. Then, in the early 21st century, systems will move on floating platforms into the open ocean. The greatest of the future challenges is that of constructing plants as large as several hundred megawatts. Much larger-diameter pipes and larger turbines are to be developed.

Chapter 2 is on ocean energy technology and describes the fundamentals of various ocean energy systems other than OTEC. Tidal energy is generated by collecting rising tidal water behind a barrier and then releasing it at ebb tide through conventional hydroelectric turbines to generate electricity. Tidal energy extraction appears to be less demanding on advanced technologies than other energy sources. The total capacity of tidal power stations is operation today in the world is 263 MW. Ocean wave energy conversion technologies utilize the kinetic energy of ocean waves to produce power. Currently, five wave energy systems generate a total of 535 kW power. Research work is being continued to find better engineering solutions. The proposed application of current energy systems in the oceans is a recent development, and has been prompted by the observations of mariners and oceanographers of swiftly flowing currents in some regions of the world. The Gulf Stream and the Florida Current are of particular interest because of the high current velocity and the proximity to large centers of population. Existing units are in the power range of several kilowatts.

Salinity gradient systems are based on an osmotic pressure difference between the two sides of a semipermeable membrane, due to the difference in salt content of fresh water and salt water. As fresh water permeates through the membrane, a head of water is developed, and a turbine can be used to extract energy from the water flow. Research work is continuing.

Chapter 3 aims at determining the economics of ocean energy. It provides insights into present and future markets, and helps toward an understanding of the environmental applications of ocean energy production. As regards OTEC, a major difficulty is that it is capital-intensive. The development of OTEC technologies is likely to be promoted by government agencies rather than by private industry. Environmental effects of OTEC are surveyed in the text.

The costs of energy from tidal energy systems decrease with growing tidal range and increase severely with the power of the plant. Environmental effects are said to be both positive and negative. Meanwhile, wave energy systems can be harmful as concerns coastal waves and current climate, the populations of fish and marine mammals, the navigation of ships, and the visual environment. In 1979, the Aeroenvironment Company (USA) conducted a conceptual design study (Coriolis Project) on a current energy system in the Gulf Stream. The project, considering very large diameter turbines, concluded on a 10000 MW plant occupying an area of 60×30 km^2, with relatively low installation and electricity costs. The Coriolis system is said to be environmentally benign; the reduction in speed of the Gulf Stream would be about 1.2%, much less than its natural fluctuation. The chances of salinity gradient systems depend on future improvements in semipermeable membranes.

Chapter 4 is dedicated to basic classical thermodynamics and basic fluid mechanics, generally and as applied to OTEC power generation. It is stated that, even assuming a Carnot cycle, the thermal efficiency of OTEC is as low as 8.6%. Actual cycle efficiencies do not exceed 1.5%. Detailed technical information is given of both closed- and open-cycle OTEC.

The book may be useful for new generations of engineers and environmental management experts. However, the reader will not be absolutely convinced concerning the environmental effects of ocean energy technologies. The problem of these effects hardens when a given kind of energy conversion tends to cover a significant portion of the total world energy consumption. On the other hand, mankind must consider all existing possibilities of survival.

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