SCIENTIFIC BOOKS

HEAT ENGINES

The Theory and Practice of Heat Engines. By D. A. WRANGHAM. xii + 756 pp. Illustrated. Cambridge at the University Press. $10.50.

IN setting out to place under one cover all the details about heat engines from history to the latest gas turbine work, the author has indeed chosen a Herculean task. Is it any wonder then that the reader on closing the book is left with a confused opinion of good, bad, indifferent? In the preface appears the sentence, "In writing this book the author has kept in mind the tremendous amount of ground which the student of to-day is expected to cover." Who expects the student to cover so much? This expectation is a debatable one pedagogically; and the resulting textbook—it is certainly not a treatise—is a debatable one from many points of view.

Again in the preface, "In the treatment of this subject the author has endeavored to reduce things to their first elements, . . . ," a noble goal indeed. But there follows, "For this reason the molecular theory has been introduced . . ." as though this were the basis of the operation of heat engines. The real basic theory of the interrelation of thermal energy to mechanical energy is the branch of science known as thermodynamics. The beauty and generality of thermodynamics lies in the fact that all the results follow from a few simple laws entirely devoid of any assumptions about the microscopic constitution of matter. Thermodynamics in heat engines as in other applications is not a sterile theory but supplies the basic formulas by which all energy computations are made. Kinetic theory on the other hand may supply to the study of heat engines an intellectually pleasing and sometimes useful qualitative picture of events, but it does not supply any useful quantitative results which can not better be obtained from thermodynamics. The author is entirely correct when he says, "There is very little to be remembered in the fundamental laws which control heat engines, but it is in their application where troubles arise," but it is disappointing to find nowhere in the book a clear statement of what these fundamental laws are. The student new to the subject must indeed be clever to find the unstated fundamental laws in operation in the "large number of worked examples . . . included . . . for this reason."

This picture of the unsatisfactory treatment of the *theory* of heat engines would not be complete without the quotation of a few of the many statements which are sufficiently vague to defy classification or which put in the same sentence unrelated material. On page 8, "In England practical engineers are brought up on the Fahrenheit scale, and can think only in terms of it. Now since these men have but few computations to make. . . ." This is an argument for the use of the Centigrade scale. On page 14, "Such a volume of gas (358 cu. ft. at N.T.P.) is known as a Mol and is a more convenient unit than a cubic foot; the misfortune is that such a quantity was not introduced before the foot, otherwise we might have had a better system of units." On page 51, "A gas is said to expand adiabatically if no caloric heat is extracted from or rejected to an *External Source,* and that internally there is neither chemical action nor other losses which would reduce the stock of internal energy." Is this statement consistent with the first law of thermodynamics? And now from later in the book, page 377, in a section on "Value of Dimensionless Ratios" there appears the following: "Further, a curve which is to represent the complete relation between the quantities involved should have the same dimensions for ordinate as for abscissae, so that the function is virtually plotted against itself." An interesting nontechnical point appears on p. 504. In discussing chemical symbols ". . . only the first letter of the English or Latin names of the commoner elements is used to denote it; whilst less common elements, . . . are distinguished by an additional letter, thus: Carbon is denoted by C, Chlorine is denoted by Cl" and Argon by A and Silver by Ag, etc.

Many of the doubtful statements in the book are to long or too technical to quote in this review, but the essence of the criticism is that the fundamental laws of nature governing heat engines are not made sufficiently clear, either by statement or in application, to even be discovered by any one but an informed reader.

So far this review has had few nice things to say about the book. To stop at this point would be unfair. The author is certainly well informed on the details of construction and operation of many types of heat engines. These include modern power plant equipment as well as those of historical importance. The brief historical sketch at the beginning of each new type of equipment was both interesting and informative.

The very generous number of examples worked in minute detail is certainly admirable. In many places the examples seem to be too difficult for the text preceding them, but otherwise are well chosen to illustrate the kinds of problems encountered in practice.

The book attempts to cover the thermodynamic, fluid flow, and heat transfer aspects of all types of heat engines and their auxiliary equipment. There is treated in order heat power cycles, air compressors and motors, reciprocating steam engines, refrigeration, condensers, steam turbines, power plants, internal combustion engines and steam boilers. While many constructional details are given, no discussion of the mechanical problems to be met in their design is attempted. However, under each type of equipment an enumerated list of advantages and disadvantages is given which helps the reader to form a balanced opinion on current models of heat engines.

The book contains a very generous number of figures and illustrations, many of which are printed in color. These add much to the clarity of the material presented as well as to amusement. Fig. 17 for example shows a Carnot cycle complete with source, the sun with a face, and a sink, icebergs, polar bear and all. In the preface the author notes that text-books like any given item of engineering practice have an average life of only ten years. This book serves to bring similar earlier texts up to date, a purpose that is accomplished, but nothing more.

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SPECIAL ARTICLES

THE IN-VITRO DESTRUCTION OF CAROTENE BY WATER EXTRACTS OF MINCED RAT STOMACHS IN THE PRESENCE OF METHYL LINOLATE

SHERMAN[1] has demonstrated that carotene administered to vitamin A deficient rats is inactivated by the simultaneous feeding of methyl linolate. The destructive action of the methyl linolate can be prevented by small amounts of α-tocopherol. It was shown that the carotene was destroyed in the gastro-intestinal tract, but the exact site and the mechanism of the destructive action was not clear. The mixing of the carotene and methyl linolate with the basal ration, *in vitro,* did not elucidate the problem, since in this case carotene destruction occurred much too slowly to explain the *in vivo* results. The same was true when the carotene and linolate were mixed with stomach or intestinal contents. Results similar to the above have been noted by Quackenbush, Cox and Steenbock[2] and by Hickman, Harris and Woodside.[3]

This paper offers a possible explanation of the above results by demonstrating the rapid *in vitro* destruction of carotene by a clear water-extract of minced rat stomach in the presence of methyl linolate.

The stomach extract is prepared by suspending the minced stomach mucosa of the freshly killed rat in ten times its weight of distilled water, allowing it to stand for 15 minutes and then centrifuging at high speed for 10 minutes. The supernatant liquid has a dry matter content of 5 mg per ml. The extract must be clear. If the minced stomach is ground in a mortar before extracting it is impossible to clarify by centrifuging and such extracts show no carotene destructive potency when tested according to the method described below.

For purposes of comparison the mode of action and potency of the so-called "carotene oxidase" or lipoxidase[4] of the soybean has been investigated. A 0.5 per cent. suspension of the ground soybean was centrifuged after standing for 30 minutes. This extract contained 2 mg of dry matter per ml.

The carotene-destroying potency of the above extracts is determined as follows. One ml. of a 0.25 per cent. solution of highly purified methyl linolate in acetone is placed in a 125 ml Erlenmeyer flask. Ten ml of water is added, followed by one ml of McIlvaine's citric acid-sodium phosphate buffer, pH 5.7, and one ml of carotene in acetone (equivalent to 68 micrograms of carotene). Finally the extract to be tested is added (usually one ml), the flask stoppered and incubated for periods up to 30 minutes at 38° C. The reaction is stopped with hydrochloric acid and the carotene is transferred to 50 ml of ethyl ether by vigorous shaking until the water phase is clear and colorless. The carotene is then determined colorimetrically by means of the Evelyn photoelectric colorimeter. For the control, a flask containing the linolate, carotene, water and buffer is incubated as above; hydrochloric acid is added and followed by the extract under test. The carotene is immediately extracted with ether. The recovery of carotene in this case is always above 95 per cent. of the amount added. The carotene destructive potency of the material under test is calculated as the percentage loss with reference to the control run at the same time.

The results of the destructive action on carotene of increments of stomach extracts of normal adult rats are shown in Table 1. The potency of the extract is greatly reduced by heating on a boiling water water bath for 15 minutes. Without methyl linolate the action of the stomach extract is insignificant.

The action of the stomach extract is very similar to that of soybean "carotene oxidase." However, some differences do exist which indicate that the active agent is not the same in both cases. From Table 2 it is evident that although the soybean enzyme is inhibited

[1] W. C. Sherman, *Proc. Soc. Exp. Biol. and Med.*, 47: 199, 1941; *Jour. Nutrition,* 22: 153, 1941.

[2] F. W. Quackenbush, R. P. Cox and H. Steenbock, *Jour. Biol. Chem.*, 145: 169, 1942.

[3] K. C. D. Hickman, P. L. Harris and M. R. Woodside, *Nature,* 150: 91, 1942.

[4] R. J. Sumner, *Jour. Biol. Chem.*, 146: 215, 1942.