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BOOK REVIEW

Thermal Regimes of Combustion. L. A. VULIS. McGraw-Hill, New York, 1961, 229 pp.

THIS publication is a literal translation from the Russian by M. D. Friedman (Translating Editor Glenn. C. Williams) of Professor Vulis's book. The original text was based upon a course of lectures given by the author at the Moscow Aviation Institute during the period 1945–1950 and was completed at the end of 1950. The subject is the formal theory of steady combustion processes in which the rate of generation of heat by chemical reaction can be represented as proportional to a function of the reactant concentration and temperature. In the simple case chosen by the author it is taken as proportional to the concentration and to an exponential function of the negative of the reciprocal temperature (the Arrhenius rate law). This assumption is discussed in Chapter I, and its use in the solution of combustion problems is illustrated by reference to thermal ignition theory for an exothermic reactant in a vessel whose walls are maintained at a constant temperature.

This example also illustrates the principle employed in the analysis of temperature equilibrium states in combustion throughout this book. At equilibrium, heat production by chemical reaction is balanced by the heat loss from the system. This condition can be determined graphically by drawing the curves representing the rates of heat production (to obtain a steady state in this example, consumption of reactant is neglected) and heat loss as functions of temperature, and locating points of intersection. The limiting condition corresponding to the temperature of ignition occurs for values of the parameters at which the curves have a point of tangency.

The first analytical treatment of this problem is by Semenov [(*Z. Physik.* (1928)] but the graphical solution appears to have been first discussed by Taffenel and Le Floche [*Compt. Rend.* (1913)].

Professor Vulis applies similar methods to the analysis of a number of problems in the efficiency and stability of combustion processes. Chapter II deals with the well-stirred adiabatic reactor, Chapter III with heterogenous combustion (burning of coal dust and of fuel/oxidant mixtures in which the extent of mixing is limited by diffusional processes) and Chapter IV with processes involving heat exchange (regenerative and dissipative) by convection and radiation. He is concerned to show that each of these problems can be solved in terms of two functions of similar form and significance. One, designated the heat elimination function, is a thermochemical equation relating to the degree of fuel conversion with the temperature of combustion, and involving, as properties of the combustible, the initial temperature and heat equivalent and, as properties of the reactor, heat transport parameters and stay-time. The other, designated the heat-liberation function, relates to the degree of fuel conversion to the rate of chemical reaction, the rate of mixing by mass transport and the stay-time. Spalding who has treated similar problems by the same method [*Some Fundamentals of Combustion*, Butterworths (1955)] designates these functions as heat balance and mass balance relations respectively. Neither terminology is entirely satisfactory. However the graphic representation of these functions is very useful in demonstrating the influence of the system parameters on the stable operating levels and stability limits of combustion in idealized reactors.

In Chapter V the author indicates how this method, hitherto applied to zero-dimensional combustion problems (spacial uniformity of concentration and temperature) can be extended to the study of one-dimensional systems approximating to furnace or combustion chamber configurations. The two last chapters contain an account of Russian work on the theory of propagation of laminar and turbulent flames in gases and an introduction to the theory of gas flow with heat addition, including that of the steady detonation wave.

Although this book was written on the basis of a student course and, according to the publishers, is intended for the use of practising engineers and students, one cannot so recommend it. The style and presentation does not economize on the reader's time or patience. The extensive use of reduced parameters is often a hindrance to rapid comprehension, as is the use of the same symbol to denote a variety of different physical properties (mitigated to some extent by the provision of two pages of notation with dimensions and designation).

It is, however, an interesting book and could be studied with profit by anyone preparing a course on the techniques of combustion theory. The bibliography lists fifty-seven references to the Russian literature.

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