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THE ELEMENTS OF REFRIGERATION.

The Elements of Refrigeration. A Text-book for Students, Engineers, and Warehousemen. By Prof. A. M. Greene, jun. Pp. vi+472. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916.) Price 18*s*. 6*d*. net.

THIS book is another striking example of the thoroughness of American (U.S.) technical educational methods, as shown by many excellent text-books—the scientific, the applied scientific, and the practical (including cost) being combined in a manner quite refreshing to British engineering students.

The table of contents discloses an excellent arrangement of matter, viz.: (1) Physical phenomena; (2) methods of refrigeration; (3) thermodynamics of refrigerating apparatus; (4) types of machines and apparatus; (5) heat transfer, insulation, and amount of heat; (6) cold storage; (7) ice-making; (8) other applications of refrigeration; (9) costs of insulation and operating costs; (10) problems.

We think, however, this arrangement would have been further improved by placing the thermodynamic section just before the problems, particularly as the author is a little disconcerting in his detailed methods. Thus, on p. 55, we have the end of a number of formulæ dealing with the air machine. The last formula is numbered (62), and is given as follows:—

$$W_c = Mc_p(T_2 - T_1) + m(q_2 + x_2r_2 - q_1 - x_1r_1)$$
$$= Mc_p(T_2 - T_1) + m(i_2 - i_1),$$

where W_c = work done in compressor.

The author then gives an example:—"To apply these formulæ, it is desired to cool a room to 0°, with cooling water at 60° F., and the data for 1 ton of refrigeration is [*sic*] to be found. With a 10° rise in the water, a 10° difference between air and cooler and a counter-current air-cooler, the temperature of the air will be reduced to 70° F. The air in the refrigerator will be −10° F."

In this problem the temperature differences are pure assumptions, but of the order generally employed by the practical man in his approximations. It would have been much better if the author had *either* kept such a problem for the last chapter, *or* taken a set of actually observed temperatures and then applied them in the formula, showing—and accounting for—the difference in the work done, as given by the formula, and the actual expenditure of energy as registered by the ordinary practical methods. If this had been done, the student would not get so hopelessly mixed between the refinements of a thermodynamic equation and the everyday approximations and assumptions of the engineer. It would further have shown the value of comparing the ideal with the actual.

It is interesting to note that the author in his tables has used the excellent material on the properties of NH_3, CO_2, and SO_2 provided by the Refrigeration Research Committee of the Institution of Mechanical Engineers (Sir Alfred Ewing, chairman). It is to be regretted, however, that he has not mentioned the recommendations of that committee respecting the unit of refrigeration.

The author states: "Refrigeration is usually measured in tons of ice-melting capacity per twenty-four hours. Since the latent heat of fusion of ice is 143·4 B.Th.U. per pound, according to the latest experiments, this unit means the removal of 286,800 B.Th.U. per twenty-four hours, or 199·2 B.Th.U. per minute."

The first of five specific recommendations of Sir Alfred Ewing's committee surmounts this difficulty of the "latest" value by suggesting "that the refrigeration produced by a refrigerating machine be expressed in calories per second." Standard conditions of temperature are then laid down in the report, and the term "rated capacity" is proposed, the following explanation being given: "Thus, a machine may be classed as having a *rated capacity of one unit* if it produces a refrigeration of one calory per second (say 342,860 B.Th.U. per day) in steady working under the standard conditions specified."

At the present moment each country takes its own unit, and as this country differs from the United States in the value of the ton (2240 lb. and 2000 lb.), initial troubles begin. Added to this is the fact that "ice-making capacity" (in addition to "ice-melting") is often used, while no two makers of refrigerating machines assume the same temperature differences.

The author should have informed his readers of these differences and put them on their guard, incidentally mentioning the British recommendations. In any case, we express the hope that this unit—one calorie per second—will become a universal standard. It is absurd for any standard or unit to be changing with the "latest" research results.

The most disappointing point in an unusually good book is to be found in the opening words of chap. vi., on "cold storage": "The purpose of cold storage is to prevent the development of life which would cause decay of living tissue; it is also used to prevent the development of living organisms." This statement is calculated to make our men of pure science see that it is time they took some interest in low-temperature effects and their practical application in the cold-storage industry. It further indicates the spade-work necessary to link up science with the preservation of foodstuffs; but, the gulf once bridged, the field of research opened out will be boundless, while the merchant and the engineer will be able to get correct fundamental ideas that will be of the greatest value in the development of an industry that is scientifically sound.

Despite the fact that the book is based on American practice, it should prove of great value to students of refrigeration in this country.

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