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49. Saturated Steam.—When steam is in contact with water as it is in a steam boiler it is found that for any particular pressure there is a definite corresponding temperature and also a definite corresponding density. Such steam is called *saturated steam.* For example, if the pressure is 78 lb. per square inch absolute the temperature is 154·6°C. and a cubic foot of it weighs 0·1786 lb. Now if this steam has its temperature lowered by 1° C. its pressure will fall to 76 lb. per square inch, a portion of it will condense to water, and its density will be reduced to 0·1742 lb. per cubic foot. This would have happened just the same if the saturated steam had been first led away into a closed vessel so as to be no longer in contact with the water and then cooled

1°C. Such a result would not be obtained by lowering the temperature of hot air. A cubic foot of hot air contained by a closed vessel would have its pressure lowered by a reduction of its temperature but its density would remain the same. For saturated steam any one of its various properties, pressure, temperature, density, etc., fixes all the others. Saturated steam at a given pressure has the greatest possible density for that pressure.

The principal properties of saturated steam are given in the Appendix, pp. 572 to 575. These properties are connected by formulæ based on the principles of thermodynamics and the results of experiments. The modern formulæ are somewhat complicated and as they are only required for the construction of steam tables they will not be discussed in this work. Associated with the various elaborate steam tables which have been published in recent years discussions on the formulæ used in their construction will be found. Simple approximate formulæ connecting the properties of steam are of little value. The properties required should be taken from the tables.

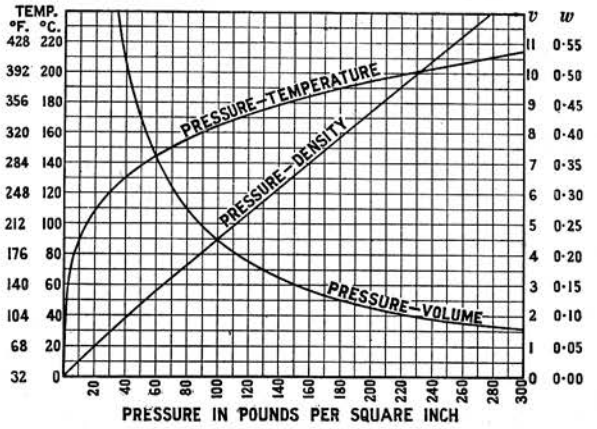

FIG. 42.—Properties of saturated steam.

An inspection of the diagrams, Figs. 42 and 43, will give a general impression of the relations between the properties of saturated steam. In Fig. 42 the abscissæ represent the pressure (p), while the ordinates represent the temperature (t), the specific volume (v), and the density (w), to the scales given. v is in cubic feet per pound, and w is in pounds per cubic foot. w is of course the reciprocal of v.

The form of the pressure-volume curve suggests that the pressure and volume may be related approximately by the formula $pv^n = C$, where C is a constant, and it would form a very good exercise for the student to apply the method of Art. 35, p. 31, to this case. It will be seen that the relation between the pressure and density is roughly a linear one. As to the pressure-temperature curve it will be noticed that the temperature increases much more rapidly with increase of pressure at low than at high pressures.

Coming now to Fig. 43, the abscissæ represent the temperature (t),

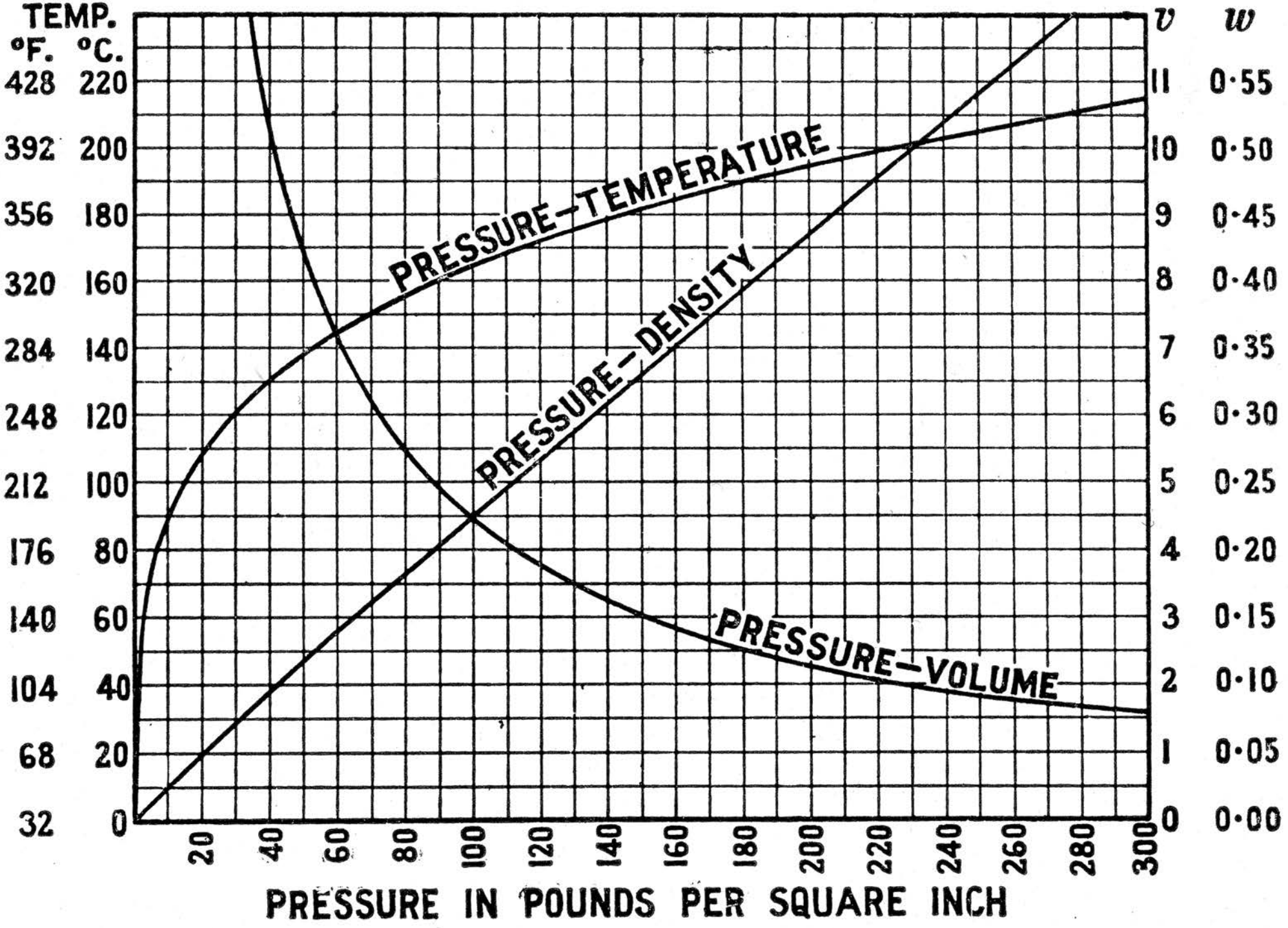

FIG. 42.—Properties of saturated steam.

while the ordinates represent the sensible heat (h), the latent heat (L), and the total heat (H), all to the same scale. Beyond the temperature 300° C. (572° F.), corresponding to a pressure of about 1250 lb. per square inch, the forms of the curves are uncertain but are probably as shown dotted. At the critical temperature t_c the latent heat is nothing

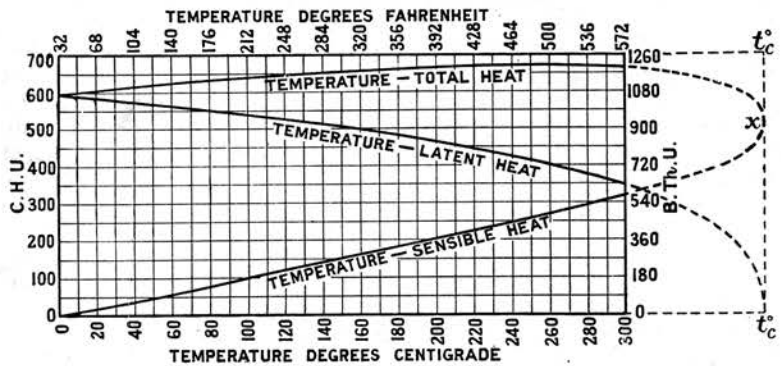

FIG. 43.—Properties of saturated steam.

and the sensible and total heat curves join up at a point x. The critical temperature of steam has generally been taken as 365° C. (689° F.). Professor Goodenough [1] has recently estimated it to be 374·6° C. (706·3° F.).

It will be observed that the three heat curves are fairly flat for the greater portion of their length and that the difference between the maximum total heat and the total heat at the freezing temperature is only about 75 C.H.U. (135 B.Th.U.).

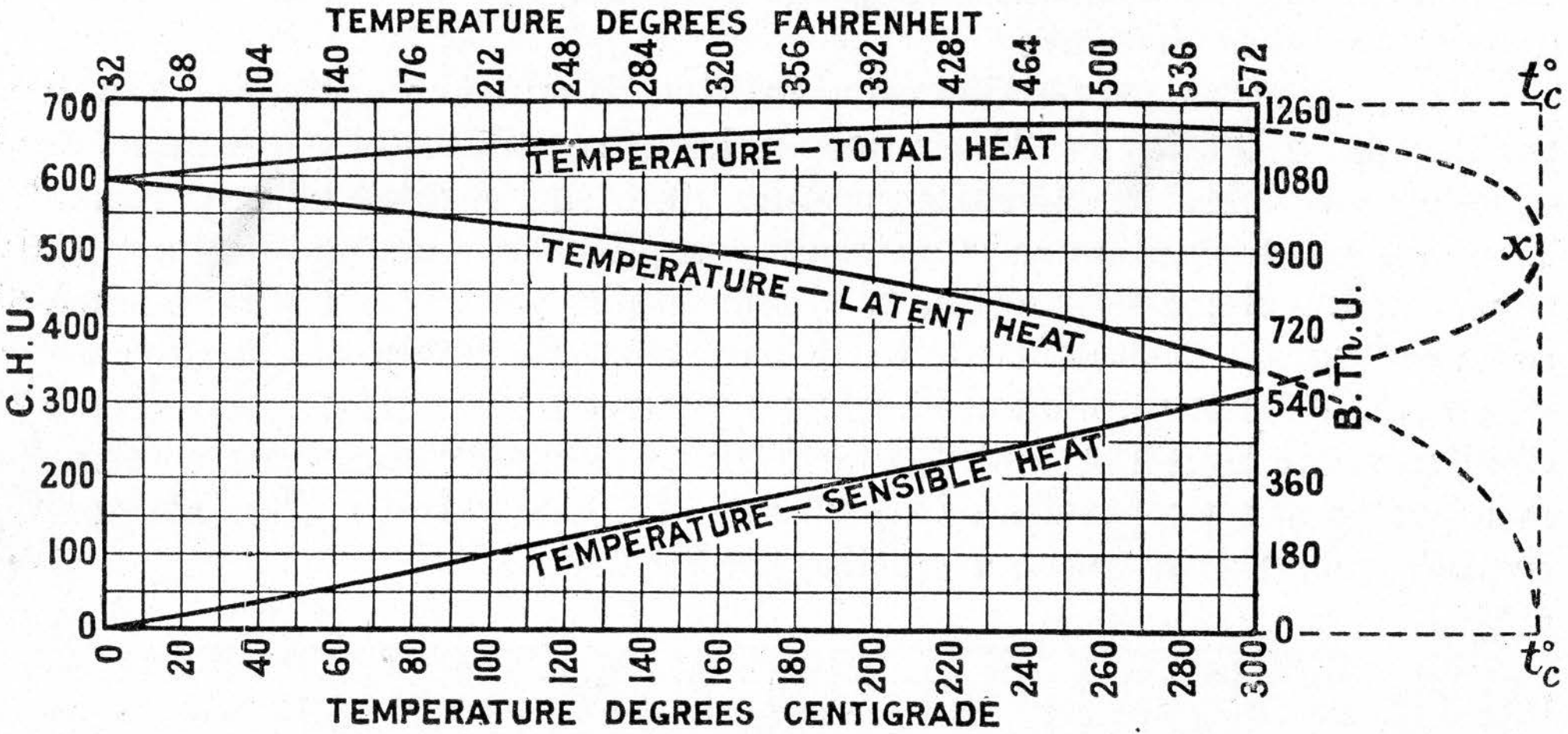

FIG. 43.—Properties of saturated steam.