where

W = weight of moisture per pound of air.
S = specific weight of water vapor compared with air as 1.
P = barometric pressure.
e = vapor pressure at temperature t.

If other gases than air are present, then the specific weight of water vapor must be taken as the density of the water vapor with reference to the density of the gas at the same pressure and temperature.

The theoretical specific weight of steam, assuming that it obeys the gas laws, would be the ratio of the molecular weight of steam to that of pure dry air. At low temperatures the actual specific weight approaches very closely this theoretical, while at high temperatures the deviation is considerable. The curve of actual specific weights of water vapor is given in Fig. 1.

From this, it is possible to compute with accuracy the weight of water vapor contained in a pound of dry air at any given vapor pressure and barometric pressure.

In a mixture of air and water vapor, a point is reached where there is a maximum quantity of water vapor present for any temperature; that is, the air is saturated when the vapor pressure corresponds to the temperature.

Air, however, is usually deficient in water vapor. That is, it is unsaturated, in which case the vapor pressure is lower than the maximum corresponding to the temperature of the mixture. The ratio of such vapor pressure to the vapor pressure of the mixture when saturated at that temperature is termed the *relative humidity*. That is:

$$\text{Per cent relative humidity} = \frac{e}{e_t}$$

$$\text{Per cent relative humidity} = \frac{D}{D_t} \text{ (approximately)} \qquad (2)$$

where e and D are the pressure and the density respectively of the vapor in the air, and e_t and D_t are the saturation pressure and density respectively of the vapor corresponding to the temperature t of the mixture.

Dew-Point

If such an unsaturated mixture of air and water vapor be cooled, without the removal of any moisture present, it will ultimately become saturated. This temperature is termed the *dew-point*, for any further cooling will result in a deposition of moisture from the mixture.

Temperature of Evaporation

In the instance cited, the air was saturated by withdrawal of heat and without change in the moisture content.

Air may also be saturated adiabatically by being brought into contact with the liquid itself without any addition or subtraction of external energy. Under this condition water vaporizes into the space occupied by the air, assuming that no heat is available from the water itself. That

is, no temperature change takes place in the water present, and the heat required for change of state must come from the sensible heat in the air itself, thus resulting in the lowering of its temperature.

The moisture content of the air, therefore, is increased and its temperature is lowered simultaneously, and it is obvious that the increase in latent heat must exactly equal the decrease in the sensible heat of the mixture. Further, this process will go on until the air becomes saturated, when no further exchange between the sensible and latent heat is possible. This final temperature at which adiabatic saturation takes place in any body of air of known temperature and moisture content is known as the *temperature of evaporation* and corresponds to the *wet-bulb* temperature.

In order that no heat exchange may take place between the water and

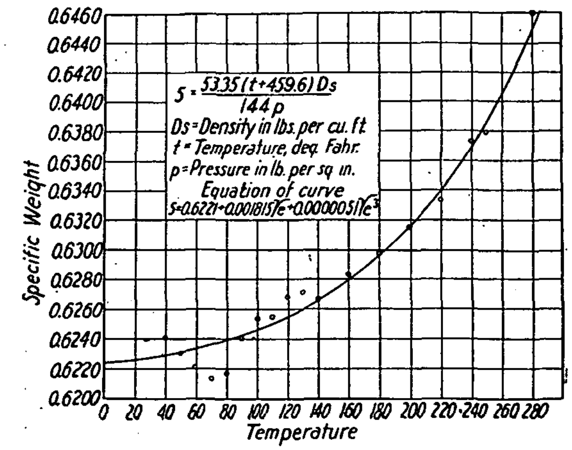

FIG. 1. SPECIFIC WEIGHT OF WATER VAPOR

the surrounding air, it is necessary that the water shall be introduced at the temperature of evaporation. On the other hand, if free water shall be exposed to a continuous current of air of a given temperature and moisture content, the water will ultimately assume of its own accord this equilibrium temperature of evaporation. This is not only logical, but has been proved experimentally. It is for this reason that an ordinary thermometer which has its bulb covered by a wetted cloth or otherwise is coated with the liquid, if protected against outside sources of heat such as radiation and if subjected to a stream of air having a definite temperature and moisture content, will indicate the temperature of adiabatic saturation. This proves the identity between what is termed the *wet-bulb temperature* and the *temperature of adiabatic saturation.*

With the ordinary sling psychrometer which is used in measuring the moisture content of air, however, there is always some radiation present and, if the wet-bulb be not strongly ventilated, the error due to radiation may be considerable. With strong ventilation, however, the radiation