

## PROPERTIES OF STEAM

Steam is water vapor which exists in the vaporous condition because sufficient heat has been added to the water to supply the latent heat of evaporation and change the liquid into vapor. This change in state takes place at a definite and constant temperature which is determined solely by the pressure of the steam. The volume of a pound of steam is the *specific volume* which decreases as the pressure increases. The reciprocal of this, or the weight of steam per cubic foot, is the *density*. (See Table 8).

Steam which is in contact with the water from which it was generated is known as *saturated steam*. If it contains no actual water in the form of mist or priming, it is called *dry saturated steam*. If this be heated and the pressure maintained the same as when it was vaporized, its temperature will increase and it will become *superheated*, that is, its temperature will be higher than that of saturated steam at the same pressure.

## REFERENCES

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## PROBLEMS IN PRACTICE

1 ● Given air at 70 F dry-bulb and 50 per cent relative humidity with a barometric pressure of 29.00 in. Hg., find the weight of vapor per pound of dry air.

Pressure of saturated vapor =  $e_s = 0.7387$  in. Hg. (Table 6).  
 From Equation 5a,

$$W = 0.622 \left( \frac{0.5 \times 0.7387}{29.00 - (0.5) \times (0.7387)} \right)$$

$W = 0.008024$  lb of vapor per pound of dry air at 70 F dry-bulb and 50 per cent relative humidity.

## CHAPTER 1. AIR, WATER AND STEAM

Approximate Method:

Weight of saturated vapor per pound of dry air =  $W_t = 0.01574$  lb (Table 6).  $0.01574 \times 0.5 = 0.00787$  lb of vapor per pound of dry air at 70 F dry-bulb and 50 per cent relative humidity.

2 ● Given air with a dry-bulb temperature of 80 F, relative humidity of 55 per cent, and a barometric pressure of 28.85 in. Hg., calculate the weight of a cubic foot of mixture.

Pressure of saturated vapor at 80 F =  $e_s = 1.0316$  in. Hg. (Table 6).

Pressure of the vapor in the mixture =  $1.0316 \times 0.55 = 0.5676$  in. Hg.

Pressure of the dry air in the mixture =  $28.85 - 0.5676 = 28.282$  in. Hg.

$pV = wR (t + 460)$  ( $R = 0.753$  when partial pressure of air is expressed in in. Hg.).  
 $28.282 \times 1 = d_a \times 0.753 \times (80 + 460)$

$$d_a = \frac{28.282}{0.753 \times 540} = 0.06955 \text{ lb} = \text{weight of dry air in 1 cu ft of the mixture.}$$

Likewise from Equation 4a,

$$d_v = \frac{0.5676}{1.21 \times 540} = 0.000868 \text{ lb} = \text{weight of vapor per cubic foot at 55 per cent relative humidity.}$$

Weight of 1 cu ft of the mixture =  $0.06955 + 0.000868 = 0.070418$  lb.

3 ● Given air with a dry-bulb temperature of 75 F, a relative humidity of 60 per cent, and a barometric pressure of 28.80 in. Hg., calculate the volume of 1 lb of the mixture.

Pressure of saturated vapor at 75 F =  $e_s = 0.8745$  in. Hg.

Pressure of vapor in the mixture =  $0.8745 \times 0.6 = 0.525$  in. Hg.

Pressure of dry air in the mixture =  $28.80 - 0.525 = 28.275$  in. Hg.

$$d_a = \frac{28.275}{0.753 \times 535} = 0.07018 \text{ lb} = \text{weight of dry air in 1 cu ft of the mixture.}$$

From Equation 4a,

$$d_v = \frac{0.525}{1.21 \times 535} = 0.000811 \text{ lb} = \text{weight of vapor per cubic foot at 55 per cent relative humidity.}$$

Weight of 1 cu ft of the mixture =  $0.07018 + 0.000811 = 0.070991$  lb.

$$\text{Volume of 1 lb of the mixture} = \frac{1}{0.070991} = 14.08 \text{ cu ft.}$$

4 ● It is desired to maintain a temperature of 80 F and a relative humidity of 50 per cent in a factory where the equipment gives off 6000 Btu per hour. If the entering air is at 70 F with an average barometric pressure of 29.92 in. Hg.; determine the relative humidity, and the pounds of air required per hour if there is no heat interchange between the walls, windows, or floors of the building.

Pressure of saturated vapor at 80 F =  $1.0316$  in. Hg. (Table 6).

Pressure of vapor in the mixture =  $1.0316 \times 0.5 = 0.5158$  in. Hg.

$$W = 0.622 \left( \frac{0.5158}{29.92 - 0.5158} \right) = 0.01091 \text{ lb.}$$

Pressure of saturated vapor at 70 F =  $0.7387$  in. Hg.

With the same specific humidity

$$0.01091 = 0.622 \left( \frac{0.7387 \times \phi}{29.92 - (0.7387 \times \phi)} \right)$$

$\phi = 69.8$  per cent relative humidity at 70 F.