

A.S.H.V.E. Research Laboratory³⁷. Another item to be considered is the radiant heat received by the body from high temperature wall and ceiling surfaces.

Example 4. Assume that the design of an air conditioning system for a theater is to be based on an outdoor dry-bulb temperature of 95 F and a wet-bulb temperature of 78 F with an indoor relative humidity of 50 per cent. According to Table 2, the dry-bulb temperature in the auditorium should be 80 F. Estimate the sensible and latent heat given up per person.

Solution. The sensible heat given up per person per hour under this condition may be obtained from Fig. 5. With an abscissa value of 80 F, Curve D for men seated at rest

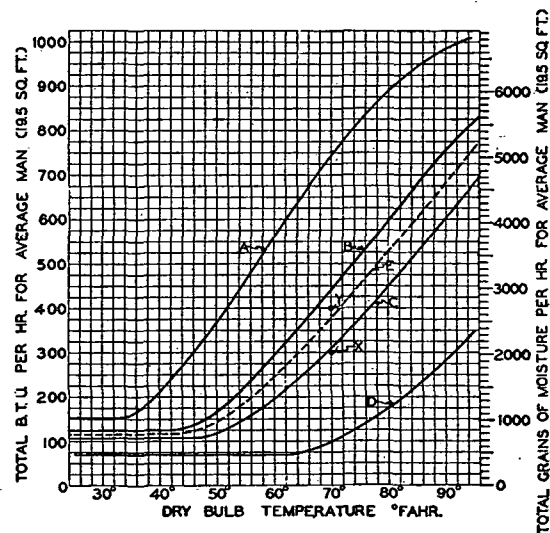


FIG. 6. LATENT HEAT AND MOISTURE LOSS FROM THE HUMAN BODY BY EVAPORATION, IN RELATION TO DRY-BULB TEMPERATURE FOR STILL AIR CONDITIONS³⁸

*Curve A—Men working 66,150 ft-lb per hour. Curve B—Men working 33,075 ft-lb per hour. Curve C—Men working 16,538 ft-lb per hour. Curve D—Men seated at rest. Curves A and C drawn from data at a dry-bulb temperature of 81.3 F only and extrapolating the relation between curves B and D which were drawn from data at many temperatures.

gives a value on the ordinate scale of 220 Btu per person per hour as the sensible heat loss. The latent heat given up by a person seated at rest per hour may be obtained from Fig. 6. With an abscissa value of 80 F, Curve D indicates a latent heat loss of 175 Btu per hour (left hand scale) or a moisture loss of 1190 grains per hour (right hand scale).

Example 5. How much sensible heat, how much latent heat and how much water vapor will be added per hour to the atmosphere of an auditorium by an audience of 1000 adults, when the dry- and wet-bulb temperatures are 75 F and 63.5 F, respectively?

Solution. From Curve D, Fig. 5, find the sensible heat loss per person for a dry-bulb temperature of 75 F and still air to be 265 Btu per hour. From Fig. 6 find the latent heat loss per person for a dry-bulb temperature of 75 F to be 134 Btu per hour and the moisture added to be 905 grains per hour. Sensible heat = $1,000 \times 265 = 265,000$ Btu. Latent heat = $1,000 \times 134 = 134,000$ Btu. Water vapor added per hour to the air in the auditorium = $1,000 \times 905 = 905,000$ grains or 129 lb.

³⁷See A.S.H.V.E. research paper entitled, Heat Transmission as Influenced by Heat Capacity and Solar Radiation, by F. C. Houghten, J. L. Blackshaw, E. M. Pugh and Paul McDermott (A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932).

The sensible and latent heat added to the air may also be found as follows: The effective temperature for dry- and wet-bulb temperatures of 75 F and 63.5 F, respectively, is 70.3 deg. From Curve D, Fig. 4, find 403 Btu as the total heat added to the air by a person for an effective temperature of 70.3 deg. From Fig. 7 find the percentage of sensible and latent heat at a dry-bulb temperature of 75 F to be 66.5 per cent and 33.5 per cent. The sensible heat added to the air in the auditorium is $1,000 \times 0.665 \times 403 = 267,995$ Btu per hour. The latent heat added is $1,000 \times 0.335 \times 403 = 135,005$ Btu per hour.

Example 6. If the dry- and wet-bulb temperatures of the auditorium were 85 F and 63 F, respectively, how much heat and moisture would be dissipated to the atmosphere?

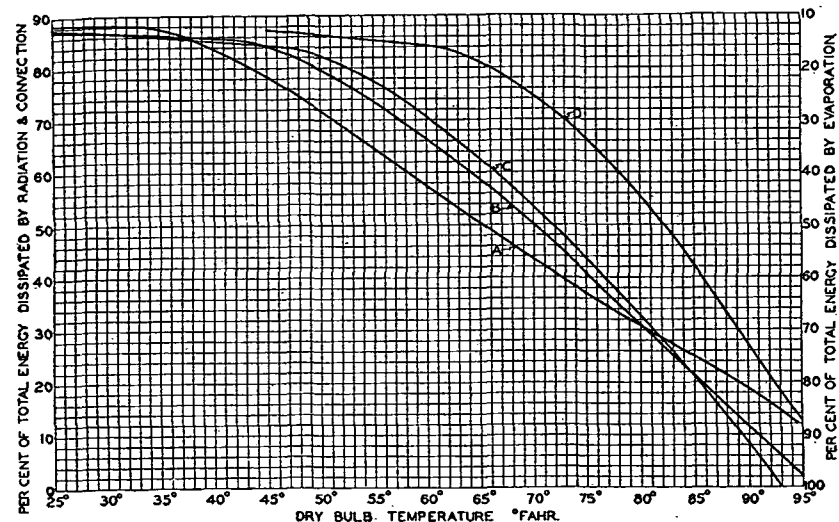


FIG. 7. HEAT LOSS FROM THE HUMAN BODY BY EVAPORATION, RADIATION AND CONVECTION IN RELATION TO DRY-BULB TEMPERATURE FOR STILL AIR CONDITIONS³⁸

*Curve A—Men working 66,150 ft-lb per hour. Curve B—Men working 33,075 ft-lb per hour. Curve C—Men working 16,538 ft-lb per hour. Curve D—Men seated at rest. Curves A and C drawn from data at a dry-bulb temperature of 81.3 F only and extrapolating the relation between curves B and D which were drawn from data at many temperatures.

Solution. From Figs. 5 and 6, respectively, the sensible and latent heat losses per person for a dry-bulb temperature of 85 F are found to be 164 and 225 Btu per hour. The water vapor added to the atmosphere is 1,520 grains per hour. The audience will then add 164,000 Btu sensible heat, 225,000 Btu latent heat and 1,520,000 grains or 217 lb of water vapor to the air in the auditorium per hour.

Examples 5 and 6 demonstrate that while the effective temperature, and hence the feeling of warmth and rate of total heat loss, do not differ greatly in the two cases, the relative proportion of sensible and latent heat loss is reversed. In order to maintain the air conditions stipulated the air conditioning equipment must remove 63.4 per cent more sensible heat in Example 5 than in Example 6; and 67.9 per cent more latent heat or water vapor in Example 6 than in Example 5. In Example 5, 66.3 per cent of the total heat loss is sensible while in Example 6 only 42.2 per cent of the total loss is sensible.

Example 7. Neglecting the gain or loss of heat to an auditorium by transmission or infiltration through the walls, windows and doors, how many cubic feet of outside air,