

with a poor distribution system or with an air supply which is too small to result in uniform distribution without drafts. Some systems of distribution produce drafts with but a few degrees temperature rise, while other systems operate successfully with a temperature rise as high as 35 F. The total air quantity introduced in any particular case is inversely proportional to the temperature rise, and depends largely upon the judgment and ingenuity of the engineer in designing the most suitable system for the particular conditions.

The changes in moisture content resulting from occupation in the atmosphere of a room supplied with various volumes of outside air is shown in Fig. 7. Data are given for an adult, 5 ft 8 in. in height, weighing 150 lb and having a body surface of 19.5 sq ft and for a child, 12 years of age, 4 ft 7 in. in height weighing 76.6 lb and having a body surface area of 12.6 sq ft. Also given in Fig. 7 is the temperature of incoming air necessary to maintain a room temperature of either 70 or 80 F as indicated assuming that there is no heat gain or loss to the room by transmission through the walls, solar radiation or other sources.

AIR MOVEMENT AND DISTRIBUTION

Stagnant warm air, not matter how pure, is not stimulating and it detracts to some extent from the quality of air. Experience, and recent field studies by the A.S.H.V.E. Research Laboratory⁴⁵ place the desirable air movement between 15 and 25 fpm under ordinary room temperatures during the heating season. Objectionable drafts are likely to occur when the velocity of the air current is 40 fpm and the temperature of the air current 2 F or more below the customary winter room temperature. Higher velocities are not objectionable in the summer time when the air temperature exceeds 80 F. Variations in air movement and temperature in different parts of occupied rooms are often indicative of relative air distribution. The work of the A.S.H.V.E. Research Laboratory indicates that an air movement between 15 and 25 fpm with a temperature variation of 3 F or less in different parts of a room, 36 in. above floor, insure satisfactory distribution. Considerable evidence was obtained in these tests to show that measurements of carbon dioxide are not essential for the study of air distribution, or for indirect measurements of outdoor air supply, which can be obtained more conveniently from the increase in moisture content of the ventilating current.

HEAT AND MOISTURE GIVEN UP BY HUMAN BODY

In conditioning air for comfort and health it is necessary to know the rate of sensible and latent heat liberation, from the human body, which in conjunction with other heat loads (see Chapters 5 and 7) determine the capacity of the conditioner. The data in common use are those of the A.S.H.V.E. Research Laboratory⁴⁶ shown in Figs. 8, 9, 10 and 11. Other useful data are given in Tables 4, 5 and 6, which are self-explanatory.

⁴⁵Classroom Drafts in Relation to Entering Air Stream Temperature, by F. C. Houghten, H. H. Trimble, Carl Gutberlet and M. F. Lichtenfels (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, July, 1935).

⁴⁶Thermal Exchanges between the Bodies of Men Working and the Atmospheric Environment, by F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant (*American Journal of Hygiene*, Vol. XIII, No. 2, March, 1931, pp. 415-431).

TABLE 4. RELATION BETWEEN METABOLIC RATE AND ACTIVITY^a

ACTIVITY	HOURLY METABOLIC RATE FOR AVG. PERSON OR TOTAL HEAT DISSIPATED, BTU PER HOUR	HOURLY SENSIBLE HEAT DISSIPATED, BTU PER HOUR	HOURLY LATENT HEAT DISSIPATED, BTU PER HOUR	MOISTURE DISSIPATED, PER HOUR	
				GRAINS	Lb
Average Person Seated at Rest ¹	384	225	159	1070	0.153
Average Person Standing at Rest ¹	431	225	206	1390	0.199
Tailor ²	482	225	257	1740	0.248
Office Worker Moderately Active	490	225	265	1790	0.256
Clerk, Moderately Active, Standing at Counter	600	225	375	2530	0.362
Book Binder ³	626	225	401	2710	0.387
Shoe Maker ² ; Clerk, Very Active Standing at Counter	661	225	436	2940	0.420
Pool Player	680	230	450	3040	0.434
Walking 2 mph ⁴ ; Light Dancing	761	250	511	3450	0.493
Metal Worker ²	862	277	585	3950	0.564
Painter of Furniture ²	876	280	596	4020	0.575
Restaurant Serving, Very Busy	1000	325	675	4560	0.651
Walking 3 mph ⁴	1050	346	704	4750	0.679
Walking 4 mph ⁴ ; Active Dancing, Roller Skating	1390	452	938	6330	0.904
Stone Mason ²	1490	490	1000	6750	0.964
Bowling	1500	490	1010	6820	0.974
Man Sawing Wood ²	1800	590	1210	8170	1.167
Slow Run ⁴	2290	—	—	—	—
Walking 5 mph ⁴	2330	—	—	—	—
Very Severe Exercise ⁵	2560	—	—	—	—
Maximum Exertion Different People ⁴	3000 to 4800	—	—	—	—

^aMetabolism rates noted based on tests actually determined from the following authoritative sources: ¹A.S.H.V.E. Research Laboratory; ²Becker and Hamalainen; ³Douglas, Haldane, Henderson and Schneider; ⁴Henderson and Haggard; and ⁵Benedict and Carpenter. Metabolic rates for other activities estimated. Total heat dissipation integrated into latent and sensible rates by actual tests for metabolic rates up to 1250 Btu per hour, and extrapolated above this rate. Values for total heat dissipation apply for all atmospheric conditions in a temperature range from approximately 60 to 90 F dry-bulb. Division of total heat dissipation rates into sensible and latent heat holds only for conditions having a dry-bulb temperature of 79 F. For lower temperatures, sensible heat dissipation increases and latent heat decreases, while for higher temperatures the reverse is true.

TABLE 5. DEGREES OF PERSPIRATION FOR PERSONS SEATED AT REST UNDER VARIOUS ATMOSPHERIC CONDITIONS

DEGREE OF PERSPIRATION ^a	ATMOSPHERIC CONDITION					
	95 Per Cent Relative Humidity			20 Per Cent Relative Humidity		
	E. T.	D. B.	W. B.	E. T.	D. B.	W. B.
Forehead clammy	73.0	73.6	72.4	75.0	87.0	60.7
Body clammy	73.0	73.6	72.4	75.0	87.0	60.7
Body damp	79.0	79.7	78.4	81.0	97.5	67.5
Beads on forehead	80.0	80.8	79.4	87.0	109.4	75.2
Body wet	84.5	85.4	84.0	86.5	108.5	74.6
Perspiration on forehead runs and drips	88.0	89.0	87.6	94.0	125.2	85.4
Perspiration runs down body	88.5	89.5	88.1	90.0	116.0	79.5

^aForty per cent of subjects registered degree of perspiration equal to or greater than indicated.