

where

H = heat to be removed from outside air entering the building; Btu per hour.

Q = volume of outside air entering building, cubic feet per hour.

v = cubic feet of outside air per pound of dry air.

h_o = enthalpy of outside air, Btu per pound of dry air.

h_i = enthalpy of inside air, Btu per pound of dry air.

The latent heat gain resulting from outside air introduced may be determined by Equation 4:

$$H_l = \frac{Q}{v} h_{fg} (W_o - W_i) \quad (4)$$

where

H_l = latent heat to be removed, Btu per hour.

h_{fg} = latent heat of evaporation at temperature at which water is condensed, Btu per pound.

W_o = humidity ratio of outside air, pounds water per pound dry air.

W_i = humidity ratio of inside air, pounds water per pound dry air.

Heat Emission of Appliances

Heat generating appliances which give off either sensible heat or both sensible and latent heat in an air conditioned enclosure may be divided into three general classes of equipment or devices: (1) electrical appliances, (2) gas appliances, and (3) steam heating appliances.

In the first group may be found such devices as lights¹², fans, motors, toasters, waffle irons, etc. The wattages are usually marked on the name-plates and it is only necessary to multiply the aggregate wattage by 3.413 (Btu per watt-hour) in order to estimate the heat added to the conditioned space by such devices in Btu per hour.

Electric motors are usually rated in units of horsepower output. To determine the corresponding input, which is the rate at which heat is added to the conditioned space by full-load operation of such motors, some idea of motor efficiency is necessary. The aggregate input in horsepower should then be multiplied by 2546 (Btu per horsepower hour). When motor efficiencies are not known, the data in Table 9 may be used.

TABLE 9. HEAT GENERATED BY MOTORS

NAME-PLATE RATING HORSEPOWER	HEAT GAIN IN BTU PER HOUR PER HORSEPOWER	
	Connected Load in Same Room	Connected Load Outside of Room
$\frac{1}{8}$ to $\frac{1}{2}$	4250	1700
$\frac{1}{2}$ to 3	3700	1150
3 to 20	2950	400

In the second group belong such appliances as coffee urns, gas ranges, steam tables, broilers, hot plates, etc. For heat generating capacities of such appliances refer to Table 10.

Judgment must be used in the application of data given in Table 10. Consideration must be given to the heat contributed by appliances which are in use at the time of peak load. The quantity of heat will

¹²Cooler Footcandles for Air Conditioning, by W. G. Darley (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1940, p. 367). Lighting and Air Conditioning Design Factors, Report of I. E. S.—A.S.H.V.E. Joint Committee on Lighting in Air Conditioning (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, September, 1941, p. 605). Lighting and Air Conditioning, by Howard M. Sharp (Heating and Ventilating, November, 1942, p. 35).

TABLE 10. HEAT GAIN FROM VARIOUS SOURCES^a

SOURCE	PER CENT NAME- PLATE RATING	PERCENTAGE OR BTU PER HOUR		
		Sensible	Latent	Total
<i>Electrically Heated Equipment</i>				
1. Electric Oven-Baking.....		80%	20%	100%
2. Baker's Oven.....	70	80%	20%	100%
3. Coffee Urn—per Gallon Capacity.....		1025	1025	2050
4. Glass Coffee Maker—per Section.....	20	90%	10%	100%
5. Warming Receptacle.....	30	80%	20%	100%
6. Plate Warmer.....	50	100%	0%	100%
7. Hot Plates.....	80	—	—	—
8. Steam Table—Water Bath Type.....	100	65%	35%	100%
9. Frying Griddles.....	75	90%	10%	100%
10. Fry Kettle.....	70	—	—	—
11. Waffle Baker.....	40	75%	25%	100%
12. Sandwich Grille.....	60	90%	10%	100%
13. Toaster—Intermittent or Timed Control.....	50	90%	10%	100%
14. Toaster—Continuous.....	100	90%	10%	100%
15. Hair Dryer in Beauty Parlor—600 w.....	—	2050	—	2050
16. Permanent Wave Machine in Beauty Parlor—24-25 w Units.....	—	2050	—	2050

Gas Burning Equipment^b

17. Gas Heated Oven—Baking.....no vent connection	70	72%	28%	100%
.....gravity vent connection	35	100%	0%	100%
18. Open Top Burner—per Hole.....	50	45%	55%	100%
19. Hot or Closed Top—per Burner.....no vent connection	100	45%	55%	100%
.....gravity vent connection	70	50%	50%	100%
20. Coffee Urn—Large 18 in. Diam.—Single Drum.....	5000	5000	5000	10,000
21. Coffee Urn—Small 12 in. Diam.—Single Drum.....	3000	3000	3000	6000
22. Coffee Urn—per Gallon of Rated Capacity.....	500	500	500	1000
23. Plate Warmer.....no vent connection	60	90%	10%	100%
.....gravity vent connection	10	100%	0%	100%
24. Steam Table—Water Bath Type.....no vent connection	60	55%	45%	100%
.....gravity vent connection	42	50%	50%	100%
25. Frying Griddles.....no vent connection	75	81%	19%	100%
.....gravity vent connection	52	90%	10%	100%
26. Fry Kettle.....no vent connection	70	72%	28%	100%
.....gravity vent connection	49	80%	20%	100%
27. Egg Boiler—per Egg Compartment.....	2500	2500	2500	5000
28. Cigar Lighter—Continuous Flame Type.....	2250	250	2500	2500
29. Curling Iron Heater.....	2250	250	2500	2500
30. Pilot Light.....	180	20	200	200

Steam Heated Equipment^c

31. Steam Heated Surface Not Polished—per Square Foot of Surface.....	330	0	330
32. Steam Heated Surface Polished—per Square Foot of Surface.....	130	0	130
33. Insulated Surface—per Square Foot.....	80	0	80
34. Bare Pipes, Not Polished—per Square Foot of Surface.....	400	0	400
35. Bare Pipes, Polished—per Square Foot of Surface.....	220	0	220
36. Insulated Pipes—per Square Foot.....	110	0	110
37. Coffee Urn—Large, 18 in. Diam.—Single Drum.....	2000	2000	4000
38. Coffee Urn—Small, 12 in. Diam.—Single Drum.....	1200	1200	2400
39. Egg Boiler—per Egg Compartment.....	2500	2500	5000
40. Steam Table—per Square Foot of Top Surface.....	300	800	1100

Miscellaneous

41. Heat Liberated By Food per Person, as in a Restaurant.....	30	30	60
42. Heat Liberated from Hot Water used direct and on towels per hour—Barber Shops.....	100	200	300

^aHeat gain from electric or gas residential ranges or cooking stoves depends on size of the family, socio-economic status of the individual, time of day for principal meal, and whether the equipment is manually or automatically controlled. Total heat gain will probably not exceed 40 per cent name-plate rating. Per cent sensible and latent heat will depend upon use of equipment; dry heat; baking or boiling.

^bName-plate ratings of gas burning equipment can be obtained from a Directory of Approved Gas Appliances and Listed Accessories, obtainable from American Gas Association.

^cSteam Requirements of Process Equipment, Report of the Commercial Relations Committee, National District Heating Association (Heating, Piping and Air Conditioning, November, 1942, p. 675).