Example 2 — Restaurant

Given:

A restaurant with the following electric appliances with a properly designed positive exhaust hood on each:

1. Two 5-gallon coffee urns, both used in the morning, only one used either in the afternoon or evening.
2. One 20 sq ft food warmer without plate warmer.
3. Two 24 x 20 x 10 inch frying griddles.
4. One 4-slice pop-up toaster, used only in the morning.
5. Two 25 lb deep fat, fry kettles.

Find:

Heat gain from these appliances during the afternoon and evening meal.

Solution:

Use *Table 50.*

	Sensible	Latent
1. Coffee Urn — only one in use:		
Sensible heat gain = 3400 × .50 =	1700	
Latent heat gain = 2300 × .50 =		1150
2. Food Warmer:		
Sensible heat gain = 20 × 200 × .50 =	2000	
Latent heat gain = 20 × 350 × .50 =		3500
3. Frying Griddles:		
Sensible heat gain = 2 × 5300 × .50 =	5300	
Latent heat gain = 2 × 2900 × .50 =		2900
4. Toaster — not in use		
5. Fry Kettles:		
Sensible heat gain = 2 × 3800 × .50 =	3800	
Latent heat gain = 2 × 5700 × .50 =		5700
Total sensible heat gain =	12,800	
Total latent heat gain =		13,250

ELECTRIC MOTORS

Electric motors contribute sensible heat to a space by converting the electrical power input to heat. Some of this power input is dissipated as heat in the motor frame and can be evaluated as

$$\text{input} \times (1 - \text{motor eff}).$$

The rest of the power input (brake horsepower or motor output) is dissipated by the driven machine and in the drive mechanism. The driven machine utilizes this motor output to do work which may or may not result in a heat gain to the space.

Motors driving fans and pumps: The power input increases the pressure and velocity of the fluid and the temperature of the fluid.

The increased energy level in the fluid is degenerated in pressure drop throughout the system and appears as a heat gain to the fluid at the point where pressure drop occurs. This heat gain does not appear as a temperature rise because, as the pressure reduces, the fluid expands. The fluid expansion is a cooling process which exactly offsets the heat generated by friction. The heat of compression required to increase the energy level is generated at the fan or pump *and* is a heat gain at this point.

If the fluid is conveyed outside of the air conditioned space, only the inefficiency of the motor driving fan or pump should be included in room sensible heat gain.

If the temperature of the fluid is maintained by a separate source, these heat gains to the fluid heat of compression are a load on this separate source only.

The heat gain or loss from the system should be calculated separately (*"System Heat Gain," p. 110*).

Motors driving process machinery (lathe, punch press, etc.): The total power input to the machine is dissipated as heat at the machine. If the product is removed from the conditioned space at a higher temperature than it came in, some of the heat input into the machine is removed and should not be considered a heat gain to the conditioned space. The heat added to a product is determined by multiplying the number of pounds of material handled per hour by the specific heat and temperature rise.

Basis of Table 53 — Heat Gain from Electric Motors

Table 53 is based on average efficiencies of squirrel cage induction open type integral horsepower and fractional horsepower motors. Power supply for fractional horsepower motors is 110 or 220 volts, 60 cycle, single phase; for integral horsepower motors, 208, 220, or 440 volts, 60 cycle, 2 or 3 phase general purpose and constant speed, 1160 or 1750 rpm. This table may also be applied with reasonable accuracy to 50 cycle, single phase a-c, 50 and 60 cycle enclosed and fractional horsepower polyphase motors.

Use of Table 53 — Heat Gain from Electric Motors

The data in *Table 53* includes the heat gain from electric motors and their driven machines when both the motor and the driven machine are in the conditioned space, or when only the driven machine is in the conditioned space, or when only the motor is in the conditioned space.

Caution: The power input to electric motors does not necessarily equal the rated horsepower divided by the motor efficiency. Frequently these motors may be operating under a continuous overload, or may be operating at less than rated capacity. It is always advisable to measure the power input wherever possible. This is especially important in estimates for industrial installations where the motor-machine load is normally a major portion of the cooling load.

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