Grate Area, Boiler Selection

The required grate area may be determined by the following formula:

$$G = \frac{H}{F \times E \times C} \quad (14)$$

where

G = required grate area, square feet.
F = calorific value of fuel, Btu per pound.
C = combustion rate, pounds per square foot of grate per hour.
E = boiler and grate efficiency, per cent.

Example 8. Using the data in Example 5, and assuming coal having a calorific value of 12,000 Btu per pound, a combustion rate of 7 lb per square foot, and a performance efficiency of 0.60, and neglecting the piping tax,

$$G = \frac{1,306,670}{12,000 \times 0.60 \times 7} = 26 \text{ sq ft}$$

Weight of Condensate

The normal weight of condensate to be handled from central fan systems may be estimated by means of the following formula:

$$W = \frac{60\, dQ \times 0.24 \times \Delta t}{h_{fg}} \quad (15)$$

where

W = weight of condensate, pounds per hour.
Q = total volume of air, cubic feet per minute.
Δt = temperature rise of air, degrees Fahrenheit.
h_{fg} = latent heat of steam in the system, Btu per pound.

Ducts and Outlets, Air Filters, Air Washers

The design of the duct system should be based on data contained in Chapter 20. Air washers and humidifiers are described in Chapter 11. For information on air filters, see Chapter 16.

Static Pressure

The total static pressure against which the system must operate may be found by summing up the static losses through the complete system from the outside air intake to the discharge outlets or nozzles. This means that the loss due to friction must be determined for each piece of apparatus involved. Most of these values may be obtained from manufacturers' data tables. For a simple system, the following static pressure drops may be assumed:

1. Outside air inlet, comprised of screen, louver and short duct, may have a loss of 0.2 in. of water.
2. A typical oil filter at rated capacity and velocity has a drop of 0.25 in. of water.
3. The loss of one row of a standard make tempering stack equals 0.09 in. water.
4. The loss of one row of a standard make preheater equals 0.10 in. water.
5. A standard humidifier at rated velocity may have a loss of about 0.35 in. water.
6. The loss through one row of a standard make reheater equals 0.12 in. water.
7. A fair assumption for duct losses on a simple system is 0.25 in. water.
8. The static pressure for a nozzle type outlet may be taken as 0.1 in. water.

The sum of these values equals 0.2 + 0.25 + 0.09 + 0.10 + 0.35 + 0.12 + 0.25 + 0.1 = 1.46 in. which is the static pressure against which the system must operate.

Fans and Control

The selection of fans may be based on data contained in Chapter 17 and for motors in Chapter 42. Because centrifugal fans reach their maximum efficiency when working against the resistance offered by the average central fan heating system, they are well adapted to such systems and are generally used. Information on temperature control for central fan systems is given in Chapter 14.

PROBLEMS IN PRACTICE

1 ● Consider a blast heating system handling 10,000 cfm. The resistance to air flow offered by one coil arrangement is 0.9 in. of water and by another coil arrangement is 0.2 in. of water. The fan operates 4000 hours per year and the combined efficiency of motor and fan is 60 per cent. Determine the annual energy saving if the second coil is used.

Difference in system resistance = 0.9 − 0.2 = 0.7 in. of water.

Reduction in power input $= \frac{10,000 \times 0.7}{6356 \times 0.60} = 1.83$ hp

Annual energy saving = 1.83 × 0.764 × 4000 = 5480 kwhr.

2 ● What saving results from recirculating some of the room air and reducing the amount of outside air?

Because outside air must be heated to room temperature, reducing the amount of outside air produces a proportionate saving in heat or fuel.

3 ● What items make up the total heating load in a central fan heating system?

1. The net heat loss from the conditioned space.
2. The heat required for evaporation of water for humidification.
3. The heat required to raise the temperature of outside air to room temperature.
4. Heat losses from pipes and ducts.

4 ● Why is it necessary to determine the total static pressure of a central fan heating system?

To select a fan of maximum efficiency and to determine the power required to operate the fan.

5 ● A group of three drafting rooms, having a total volume of 27,000 cu ft, a transmission loss of 110,100 Btu per hour, and an infiltration loss of 34,200 Btu per hour on the basis of 0 F outdoors and 70 F room temperature, is to be heated by a recirculating hot blast heating system with air entering the rooms at 116 F. How many cubic feet per minute, measured at 70 F, will be required?

Substitute in Equation 3. H = 110,100 + 34,200 = 144,300 Btu per hour; t_y = 116 F; t = 70 F; $Q = \frac{144,300}{60 \times 0.07495 \times 0.24\,(116 - 70)} = 2900$ cfm.

6 ● In the preceding question, if the hot air loses 4 F between heater and rooms, how many pounds of steam per hour at 1-lb gage will the heating sections condense?