HOT WATER HEATING SYSTEMS

By
F. E. Gieseke, College Architect

The Estimated Cost Of Heating Hart Hall

To determine the cost of heating a building for a given period of time it is necessary to know the quantity of heat lost by the building during that period and the cost of producing heat and of delivering it to the building.

In determining the heat lost by a given building, Hart Hall, for example, it is customary to assume that the indoor temperature should be maintained at 70 degrees, and that the heat lost by the building is proportional to the differences of the indoor and outdoor temperatures. For example, for indoor and outdoor temperatures of 70 degrees and 25 degrees, and of 70 degrees and 55 degrees, the respective temperature differences are 45 degrees and 15 degrees and it is assumed that the heat loss of the building is three times as large in the former as in the latter case.

It is known from experiment and from experience how much heat will flow through various types of building materials and it is therefore comparatively easy to calculate the heat losses of buildings under given conditions. For example, Hart Hall will lose about 850,000 B. t. u. per hour when the outdoor temperature is 25 degrees, the hall temperature 55 degrees and the room temperature 70 degrees.

In addition to the heat lost by a building through the walls, floors and roof, heat is also lost with the air which is used for ventilation, and which flows through the building, entering at the outdoor temperature and leaving at the indoor temperature.

At 70 degrees one B. t. u. will heat about 55 cubic feet of air one degree. If we assume for Hart Hall that every occupant should be provided with 1400 cubic feet of outdoor air per hour, the heat loss for ventilation will be about 350,000 B. t. u. per hour when the outdoor temperature is 25 degrees; the total heat loss for the building will, therefore, be about 1,200,000 B. t. u. per hour.

The most efficient method of securing the ventilation referred to is to lower the upper sash and to raise the lower sash. When that is done outdoor air will flow into the room through the lower part of the window and indoor air will flow out through the upper part of the window, and the outdoor atmospheric pressure will be equal to the indoor atmospheric pressure at an elevation at or near the center of the height of the window. The zone in which the two atmospheric pressures are equal is the neutral zone. The flow of the air through the windows can be demonstrated by a simple calculation. Let us assume that the windows are six feet high, that the neutral zone is at the center of the height of the windows, that 70 degrees air weighs 75 pounds and 25 degrees air 82 pounds per 1,000 cubic feet. If the atmospheric pressure at the neutral zone is W pounds per square foot, the outdoor pressure three feet above the neutral zone will be W—3 x .082 and the indoor pressure will be W—3 x .075. The indoor pressure is therefore 0.007 pounds per square foot greater than the outdoor pressure; this excess pressure causes the air to flow outward through the upper part of the window. A similar calculation will show that at the bottom of the window the outdoor pressure is about 0.007 pounds per square foot greater than the indoor pressure and will cause the air to flow inward at the bottom of the window.

Knowing that the heat loss of Hart Hall under normal conditions is 1,200,000 B. t. u. when the outdoor temperature is 25 degrees, the heat loss for any other outdoor temperature can be determined by proportion. For example, when the outdoor temperature is 55 degrees, the heat loss will be 400,000 B. t. u. per hour.

The next step in the calculation is to determine the probable total heat requirement for the heating season. The period during which heating may be required varies with the latitude. For College Station we may assume it to extend from October 1 to May 1, a period of seven months. The average mean temperature for this period at College Station for the past 29 years was 59 degrees, according to the U. S. Weather Bureau records.

Assuming that the heat is to be supplied to buildings only when the outdoor temperature is 65 degrees or lower, the mean indoor and outdoor temperature difference is 65 - 59 or 6 degrees for the seven-month heating period. If we apply the name "degree-day" to the quantity of heat which must be supplied to a building during a period of 24 hours when the outdoor temperature is one degree below 65 degrees the total quantity of heat to be supplied to the building at College Station will be 212 x 6, or 1272 degree-days.

The concept "degree-day" just described was first proposed by the American Gas Association. It is now in general use for calculating the heat requirements for different localities. According to a diagram published in Heating and Ventilating, February, 1930, the number of degree-days along the 98th meridian varies about as follows: South Texas, 1,000, North Texas, 2,500, Oklahoma, 3,000, Kansas, 5,000, Nebraska, 6,500, South Dakota 7,500, North Dakota, 9,500.

I believe that the heating load, 1272 degree-days calculated above for College Station, is too small for two reasons. First, because I believe we should reckon our degree-days with 70 degrees as the basis instead of with 65 degrees, and second, because the mean temperature cited above is the mean of the daily maxima and daily minima and this does not represent the mean temperature for which heat must be supplied. On many days from October 1 to May 1 the maximum temperature at College Station is above 70 degrees. I believe these high temperatures should be replaced by 70 degrees before the mean temperature for heating purposes is calculated. For example, if we consider the heating season October 1, 1928, to May 1, 1929, and campare the actual mean temperatures with those found by substituting 70 degrees for all maximum temperatures higher than 70 degrees, we secure the following monthly and seasonal mean temperatures:

Oct.	73.8	56.5
Nov.	57.4	55.0
Dec.	49.8	49.1.
Jan.	50.7	49.8.
Feb.	44.8	44.4.
Mar.	63.3	57.4.
Apr.	71.0	60.0.
Season	59.7	53.2.

And we find that the mean temperature for heating purposes is 53.2 divided by 59.7, or 0.888 of the actual mean temperature for this particular period.

If the same percentage may be applied to the 29-year period referred to above, the desired mean temperature is 0.888 x 59, or 52.4.

The number of degree-days which should then be used for heat calculations at College Station will be 212 times 65 minus 52.4, or 2671, instead of 1272 as calculated above. However, if the number of degree-days are calculated with 70 degrees instead of 65 degrees as the basis, the number will be 212 times 70 minus 52.4, or 3731 instead of 2671.

It was shown above that the heat loss of Hart Hall is 1,200,000 B. t. u. per hour when the outdoor temperature is 25 degrees. If the outdoor temperature were to remain constant at 25 degrees for an entire day

(Continued on page 3)