$H_t + \frac{H_i}{2}$. If a building has no interior walls or partitions, whatever air enters through the cracks on the windward side must leave through the cracks on the leeward side, and only half of the total crack should be used in computing the infiltration for each side and end of the building. Under these conditions it is sufficiently accurate to use the total calculated heat loss (H) for the building. If the average wind velocity during the heating season differs from that upon which H_i was derived, the value of H should be corrected accordingly.

Of course, where the required heating surface is estimated by empirical or rule-of-thumb methods, refinements in approximating fuel consumption are not warranted, but rule-of-thumb methods often lead to unsatisfactory results and should be avoided in heating work where more accurate methods are available. It should be emphasized that the value of H in Equation 1 is the total heat loss of the building after making the proper allowance for infiltration.

CALORIFIC VALUES AND HEATING EFFICIENCIES

The calorific values of fuel oils and gas can be ascertained with reasonable accuracy. The values for various grades of oil are given in Table 3, Chapter 27. The calorific value of gas can always be obtained from the local utility company. Values for natural gas are given in Table 4, Chapter 27; manufactured gas usually has a calorific value of about 535. Coals have a larger range and may vary for the same type of coal, depending on its ash content. For general purposes where specific data are lacking, values can be taken from Table 1, Chapter 27.

To decide on the correct efficiency to use is a more difficult matter, particularly if the estimate is being made without a full knowledge of the equipment for burning the fuel and the care the furnace will receive. Efficiencies usually are given in the catalogs of manufacturers of furnaces and boilers, but these values are obtained under test conditions and do not allow for poor attendance, defects in installation, or poor draft. On the other hand, such efficiencies assume that all the heat radiated from the outside of the heaters or casings as sensible heat of the flue gases is lost, whereas, if the heater is installed in the building being heated, a considerable portion of these losses may help to heat the building[2]; how much of this it is legitimate to use in increasing the value of E will depend on whether H included the heat losses in the cellar, and on the construction of the chimney. Except for an interior chimney, the heat transferred through the chimney wall to the building will be very small. Chimney allowances should be greater for lower test efficiencies. Thus an insulated furnace will give a high efficiency on test but will not heat the cellar. A modern gas furnace will have a high efficiency with a correspondingly low flue gas temperature and hence there will be very little heat from the flue pipe.

For great exactitude the value for E should take care of inefficiency in the heat distribution in the building because of such losses as excessive heating of the walls behind the radiators and excessive stratification. It is preferable, however, to include these losses in the value of H, and to limit E to the fuel burning equipment.

Automatic fuel burning equipment, whether for coal, oil or gas, will tend to save fuel and will therefore produce a higher efficiency if thermostatically controlled, but on the other hand automatic equipment tends to make the householder prolong his heating season and maintain a higher temperature in the house in the early fall and late spring.

[2]Analysis of the Over-All Efficiency of a Residence Heated by Warm Air, by A. P. Kratz and J. F. Quereau (A.S.H.V.E. TRANSACTIONS, Vol. 35, 1929).

NON-HEATING PERIODS

Obviously, the theoretical fuel consumption will be reduced considerably by not operating the heating plant at night. Allowance for this may be made in either of two ways: (1) by estimating the average inside temperature t, or (2) by arbitrarily assuming a certain reduction in the fuel consumption.

The first procedure is, of course, the more accurate. If, for example, the daytime temperature is to be 70 F, and the temperature from 12 midnight to 6 a.m. is to be maintained by thermostatic control at 50 F, then the average daily inside temperature t will be $\frac{18 \times 70 + 6 \times 50}{24}$ or 65 F. Strictly speaking, this average inside temperature would apply only when the outside night temperature averages below 50 F, but this fact usually is not of sufficient importance to warrant consideration. If the average outside temperature during the heating season is 30 F, the fuel saving would be approximately $100 \times \frac{70 - 65}{70 - 30}$ or 12.5 per cent. In this case, the additional saving in fuel due to the cooling of the air and structural materials to 50 F would be offset by the heating-up load in the morning.

As to the second procedure, it may be arbitrarily assumed that a saving in the fuel consumption of from 10 to 30 per cent, depending on conditions, will result if the heat is shut off after working hours, and the building is heated to the required temperature during the period of occupancy each day. This, of course, is a general statement and wherever possible the average temperature should be estimated from the proportionate lengths of the occupancy and non-occupancy periods and the corresponding temperatures for these periods. Any deviation from the assumed inside temperature will result in a variation in the estimated fuel consumption.

HEAT CAPACITY OF BUILDINGS

The heat required to warm the cold building and contents is a factor to be considered. Under certain conditions, the cooling of the structure and contents will, to some extent, compensate for the heat required to rewarm the building. For example, if the building is under thermostatic control and the day and night temperatures are say 70 F and 50 F, respectively, there will be a period during which no heat will be called for while the building is cooling to 50 F, and the saving resulting therefrom will correspond to the additional heat required to bring the building and contents back to the daytime temperature. If in estimating the fuel consumption the average daily inside temperature is based on the proper day and night temperatures and periods, the heat required to warm the structure may be neglected.