

secondary air will not react with any unburned gases unless the mixture is subjected to high temperatures.

The air requirements of oil and gas burners are discussed in Chapter 10, Automatic Fuel Burning Equipment.

DRAFT REQUIREMENTS

The draft required to effect a given rate of burning the fuel is dependent on the following factors:

1. Kind and size of fuel.
2. Grate area.
3. Thickness of fuel bed.
4. Type and amount of ash and clinker accumulation.
5. Amount of excess air present in the gases.
6. Resistance offered by the boiler passes to the flow of the gases.
7. Accumulation of soot in the passes.

Insufficient draft will necessitate additional manipulation of the fuel bed and more frequent cleanings to keep its resistance down. Insufficient draft also restricts the control that can be accomplished by adjustment of the dampers.

The quantity of excess air present has a marked effect on the draft required to produce a given rate of burning. If the excess is caused by holes in the fuel bed, or an extremely thin fuel bed, it is often possible to produce a higher rate of burning by increasing the thickness of the bed. The thickness of the fuel bed should not, however, be increased too much because the increased draft resistance will reduce the rate of primary air supply and the rate of burning.

For amount of draft required see Chapter 9, Chimneys and Draft Calculations.

DRAFT REGULATION

Because of the varying heating load demands present in most installations it is necessary to vary the rate of fuel burning. The maintenance of the proper air supply for the various rates of burning is accomplished by regulation of the drafts. Correct and incorrect methods of draft regulation are shown in Fig. 3. The air enters through the ashpit draft door, firing door and by leaks in the setting, whereas the gases leave only through the uptake. By throttling the gases with the damper in the

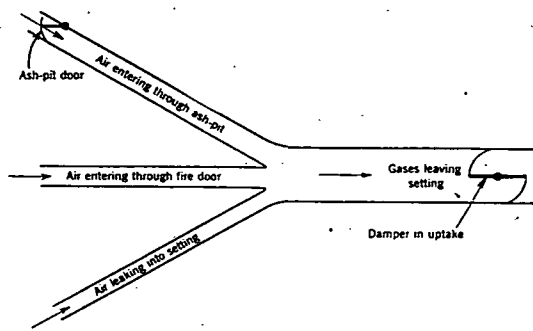


FIG. 3. CORRECT AND INCORRECT METHODS OF DRAFT REGULATION IN A HAND-FIRED FURNACE

uptake all the air entering by each of the three intakes is reduced in the same proportion. If the ashpit draft door is closed the air admitted through the ashpit is reduced while it is increased through the other two intake openings.

Methods of control of draft conditions when burning oil or gas are noted in Chapter 10, Automatic Fuel Burning Equipment.

CLASSIFICATION OF COALS

The complex composition of coal makes it difficult to classify it into clear-cut types. Its chemical composition is some indication but coals having the same chemical analysis may have distinctly different burning characteristics. Users are mainly interested in the available heat per pound of coal, in the handling and storing properties, and in the burning characteristics. A description of the relationship between the qualities of coals and these characteristics requires considerable space: a treatment applicable to heating boilers is given in a Bureau of Mines Bulletin².

Coal composition may be expressed by either an *ultimate* or *proximate* analysis. In the ultimate analysis the proportions of carbon, hydrogen, oxygen, nitrogen, sulphur, and ash are determined. This form of analysis is difficult to make and is used only for extremely close studies. The proximate analysis is more easily made and is satisfactory for most purposes. In this analysis, the proportions of moisture, volatile matter, fixed carbon, and ash are determined. Moisture is obtained by noting the loss of weight of a sample of coal when dried at about 220 F. To determine volatile matter, the dried sample is heated to about 1750 F in a closed crucible, and the loss of weight is noted. The sample is then burned in an open crucible, and the accompanying loss of weight represents the fixed carbon. The unburned residue is ash. Although determined separately, the sulphur content is frequently reported with a proximate analysis.

Other important qualities of coals are the screen sizes, ash fusion temperature, friability, caking tendency, and the qualities of the volatile matter. In considering these factors the following points are of interest. The volatile products given off by coals when they are heated differ materially in the ratios by weight of the gases to the oils and tars. No heavy oils or tars are given off by anthracite, and very small quantities are given off by semi-anthracite. As the volatile matter in the coal increases to as much as 40 per cent of ash and moisture-free coal, increasing amounts of oils and tars are released. For coals of higher volatile content, the relative quantity of oils and tars decreases, so it is low in the sub-bituminous coals and in lignite. The percentage of ash and its fusion temperature do not indicate the composition or distribution of its constituents.

A classification of coals is given in Table 5, and a brief description of the kinds of fuel is given in the following paragraphs, but it should be recognized that there are no distinct lines of demarcation between the kinds, and that they graduate into each other.

Anthracite is a clean, dense, hard coal which creates little dust in handling. It is comparatively hard to ignite but it burns freely when well started. It is non-caking, it burns uniformly and smokelessly with a short flame, and it requires no attention to the fuel bed between firings. It is capable of giving a high efficiency in the common types of hand-

²Five Hundred Tests of Various Coals in Househeating Boilers (U. S. Bureau of Mines Bulletin No. 276).