Class 4 Stokers, Large Commercial, Small High Pressure Plants

Stokers in this group vary widely in details of mechanical design and the several methods of feeding coal previously described may be employed Such methods of applying power to the fuel conveying mechanism as, continuous gear train transmission, ratchet-type speed reducer, hydraulic cylinder and steam cylinder are used. Varying methods of ash disposal are found in this class.

Large Stokers

This class includes stokers with hourly burning rates of over 1200 lb of coal per hour. The prevalent stokers in this field are: (*a*) overfeed flat grate, (*b*) overfeed inclined grate, (*c*) underfeed side cleaning, and (*d*) underfeed rear cleaning.

Overfeed inclined grate stokers are seldom built in sizes of over 500 hp and are not as extensively used as other types of stokers.

Underfeed side cleaning stokers are made in sizes up to approximately 500 hp and in this field are extensively used. These stokers are not so varied in design as those in the smaller classes although the principle is much the same. Practically all of them are of the front coal feed type, either power driven or steam driven. Dump plates at the side are manually operated. These stokers are heavily built and designed to operate continuously at high boiler ratings with a minimum amount of attention. Because of the fact that all volatile gases must pass through the fire before reaching the combustion chamber, these stokers will operate smokelessly under ordinary conditions. Also because of the fact that these stokers are always provided with forced draft, they are the most desirable type for fluctuating loads or high boiler ratings.

In the design of the grates for supporting the fuel between the retort and the ash plates, the stokers differ in providing for movement of the fuel during combustion. Some stokers are designed with fixed grates of sufficient angle to provide for this movement as the bed is agitated by the incoming fuel, while others have alternate moving and stationary bars in this area and provide for this movement mechanically. In either type, with proper operation, all refuse will be deposited at the dump plate. Recent developments in this type of stoker provide for sliding distributor blocks along the bottom of the retorts which give flexibility in providing proper distribution of fuel over the grate area and assist in preventing coke masses when strong coking coals are used. Another difference in these stokers is that some use a single air chamber under the whole grate area thus having the same air pressure under the ignition area as under the rest of the grate, while others have a divided air chamber using the full air pressure under the ignition area and a reduced air pressure under the remainder of the grate. These stokers vary in size from approximately 5 sq ft to a maximum of 8½ sq ft.

The most prevalent type of rear cleaning underfeed stoker is the multiple retort design. Occasionally double or triple retort side cleaning underfeeds are made. The multiple retort underfeed stoker is made for the largest sizes of boilers for large industrial plants and central stations. This stoker has reached a very fine stage of development mechanically and in the matter of air supply and control. In some instances zoned air

control has been applied both longitudinally and transversely to the grate surface. Ash dumps on smaller sizes are sometimes manually operated.

The Combustion Process

Due to the marked differences in design and operating characteristics of stokers and the widely differing characteristics of stoker fuels, it is difficult to generalize on the subject of combustion in automatic stokers.

In anthracite stokers, which are almost exclusively of the small (Class 1) underfeed type, burning takes place within the stoker retort. The ash and refuse of combustion spills over the edge of the retort into an ashpit or receptacle from which it may be removed either manually or automatically. Anthracite is usually supplied for stoker firing in No. 1 buckwheat or No. 2 buckwheat size. Those stokers burning coke operate in a similar manner to anthracite stokers.

Since the majority of bituminous coal stokers used in heating plants operate on the underfeed principle some general observations of their operation are given.

When the coal is fed from the hopper or bin into the retort it is generally degraded to some extent and some segregation of sizes occurs. Because of these factors there may be some difference in the actions occurring in the various portions of the retort.

The coal moving upward in the retort toward the zone of combustion established by previous kindling of the fire is heated by conduction and radiation from the zone of combustion. As the temperature of the coal rises it first gives off moisture and occluded gases, which are largely non-combustible. When the temperature increases to around 700 or 800 F, the coal particles become plastic, the degree of plasticity varying with the type of coal.

A rapid evolution of combustible volatile matter occurs during and directly after the plastic stage of the coal. The distillation of volatile matter continues above the plastic zone and the coal is coked. The strength and porosity of the coke formed will vary according to the size and characteristics of the coal used.

As more coal is fed from below the mass of coke continues to grow forming a coke *tree*, *plug* or *spar* as it is variously designated. After a period of time, dependent upon the strength of the coke formed, pieces of the coke *tree* break off and fall upon the hearth surrounding the retort or within the retort itself where they are burned.

While part of the ash fuses into particles at the surface of the coke as it is released, most of it is freed in unfused flakes or grains. The greater part of this unfused ash remains on the hearth or dead plates although a part may be expelled from the furnace with the gases.

The ash layer becomes thicker with time and that near the retort, being exposed to temperatures which are high enough at times, fuses into a clinker. The temperature attained in the fuel bed, the chemical composition and homogeneity of the ash, and the time of heating are factors which govern the degree of fusion.

Bituminous coal stokers of the Class 1 type operate on the principle of the removal of ash as clinker and clinker tongs are provided to facilitate