

Smoke density is usually measured by comparison with the Ringelmann Chart (Fig. 1). In making observations of the smoke issuing from a chimney, four cards ruled like those in Fig. 1, together with a card printed in solid black and another left entirely white, are placed in a horizontal row and hung at a point about 50 ft from the observer and as nearly as convenient in line with the chimney. At this distance, the lines become invisible, and the cards appear to be of different shades of gray, ranging from very light gray to almost black. The observer glances from the smoke coming from the chimney to the cards, which are numbered from 0 to 5, determines which card most nearly corresponds with the color of the smoke, and makes a record accordingly, noting the time. Observations are made continuously during say one minute, and the estimated average density during that minute recorded, and so on, records being made once very minute. The average of all the records made during a boiler test is taken as the average figure for the smoke

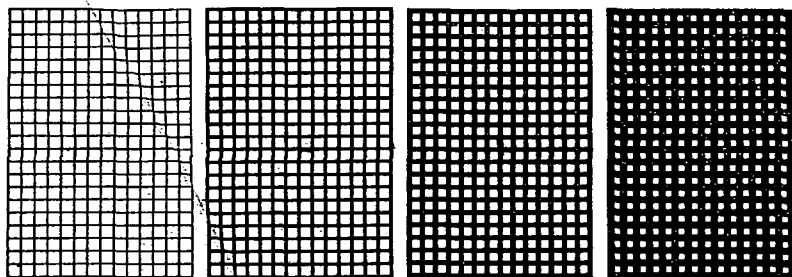


FIG. 1. RINGELMANN SMOKE CHART

density during the test, and the entire record is plotted on cross-section paper in order to show how the smoke varied in density from time to time.

Methods of Reducing Smoke Discharge

In general, time, temperature and turbulence are the essential requirements for smokeless combustion. Anything that can be done to increase any one of these factors will reduce the quantity of smoke discharged.

Checker or Alternate Firing, in which the fuel is fired alternately on separate parts of the grate, maintains a higher furnace temperature and thereby decreases the amount of smoke.

Coking and Firing, in which the fuel is first fired close to the firing door and the coke pushed back into the furnace just before firing again, produces the same effect. The volatiles as they are distilled thus have to pass over the hot fuel bed and will be burned if they are mixed with sufficient air and are not cooled too quickly by the heat-absorbing surfaces of the boiler.

Steam or Compressed Air Jets, admitted over the fire, create turbulence in the furnace and bring the volatiles of the fuel more quickly into contact with the air required for combustion. These jets are especially helpful

for the first few minutes after each firing. *Frequent firings* of small charges shorten the smoking period and reduce the density. *Thinner fuel beds* on the grate increase the effective combustion space in the furnace, supply more air for combustion, and are sometimes effective in reducing the smoke emitted. A *lower volatile coal* or a higher gravity oil always produce less smoke than a high volatile coal or low gravity oil used in the same furnace and fired in the same manner.

The installation of more modern or better designed fuel burning equipment, or a change in the construction of the furnace will often reduce smoke. The installation of a Dutch Oven will increase the furnace volume and will raise the furnace temperature, and often produces satisfactory results.

New Installations

In the case of new installations, the problem of smoke abatement can be solved by the selection of the proper fuel burning equipment and furnace design for the particular fuel to be burned and by the proper operation of that equipment. Constant vigilance is necessary to make certain that the equipment is properly operated.

DUST AND CINDERS

Dust and *cinders* in the air are those particles of solid matter larger than the largest smoke particle. (See definition of dusts on page 477, Chapter 33, Air Cleaning Devices). The term *dust* is usually applied to the particles of completely burned ash of small size, and the term *cinder* is usually applied to the particles of coke and ash of appreciable size discharged with the gases of combustion from burning coal.

The sources of these particles are numerous, such as roads and streets, plowed ground, insects, etc., but the particles of greatest concern are those discharged into the atmosphere along with the gases of combustion from solid fuel. Both dust and cinders are discharged from the smoke outlets of plants where coal is the fuel used. When the coal is fired on grates the cinders may cause annoyance, and when the coal is pulverized and burned in suspension, the dust problem can be serious.

The cinder particles are usually larger in size than the dust particles, they are gray or black in color, and are abrasive. Being of a larger size the range within which they may annoy is limited.

The dust particles are usually extremely fine, they are light gray or yellow in color, and are not as abrasive as cinder particles. Being extremely fine, they are readily distributed over a large area by air currents.

The nuisance created by the solid particles in the air is a function of the size and physical characteristics of the individual particles. The difficulty of catching the dust and cinder particles is principally a function of the size and specific gravity of the particles.

Nature's Dust Catcher

Nature has provided means for catching solid particles in the air and depositing them upon the earth. A dust particle forms the nucleus for each rain drop and the rain picks up dust as it falls from the clouds to the earth. In fact, without dust in the air to form the nuclei for rain drops it