



Standard Test Method for Effect of Air Supply on Smoke Density in Flue Gases From Burning Distillate Fuels¹

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1. Scope

1.1 This test method covers the evaluation of the performance of distillate fuels from the standpoint of clean, efficient burning. It is intended primarily for use with home heating equipment burning No. 1 or No. 2 fuel oils. It can be used either in the laboratory or in the field to compare fuels using a given heating unit or to compare the performance of heating units using a given fuel.

1.2 The values in inch-pound units are to be regarded as the standard. The values in parentheses are provided for information only. Arbitrary and relative units are also used.

NOTE 1—This test method applies only to pressure atomizing and rotary-type burners.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 2156 Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels²

3. Terminology

3.1 Description of Terms Specific to This Standard:

3.1.1 *smoke density*—the concentration of smoke in the flue gas, measured as a Smoke Spot Number as described in Test Method D 2156.

3.1.2 *flue-gas carbon dioxide (CO₂)*—the percentage concentration of carbon dioxide in the flue gas, measured by conventional Orsat analysis, or the equivalent.

3.1.3 *net stack temperature*—the difference between the stack temperature and the ambient temperature of the air near the inlet to the burner.

3.1.4 *excess combustion air*—the percentage of air entering the equipment over and above that needed for stoichiometric

conversion of the fuel to the ultimate combustion products, essentially CO₂ and water, for a normal fuel. This may be calculated from the percentage CO₂ in the flue gas and the carbon-hydrogen ratio of the fuel.

3.1.5 *efficiency*—defined as the percentage of gross heat of combustion of the fuel which is retained by the equipment and which does not pass out in the flue gases.

4. Summary of Test Method

4.1 The flue-gas smoke density is measured for various amounts of combustion air while the burner is operating at equilibrium conditions. Results are expressed as a plot of smoke density as a function of flue-gas carbon dioxide (CO₂) content, or alternatively, as a function of percentage excess combustion air.

5. Significance and Use

5.1 This test method relates efficiency of operation of domestic heating equipment to clean burning. Reducing combustion air in a burner gives more efficient operation. The extent to which combustion air can be reduced is limited by the onset of unacceptable smoke production. By delineating the relation between smoke density and air supply, this test method (together with net stack temperature data) defines the maximum efficiency for a given installation at any acceptable smoke level.

5.2 For certain types of equipment, such as the rotary wall-flame burner, too much excess air will cause smoke as well as too little. For these cases, the point of minimum excess air at the acceptable smoke level indicates the optimum efficiency.

5.3 The operating temperatures of the equipment will affect these test results. The relation of excess air to smoke density is thus susceptible to some change at different points in an operating cycle. In practice, an adequate compromise is possible by operating the burner for 15 min before any readings are recorded and then obtaining the test data within a succeeding 25-min period.

5.4 Under laboratory conditions, CO₂ readings are reproducible to $\pm 0.3\%$ and smoke readings are reproducible to $\pm 1/2$ smoke spot number.

6. Apparatus

6.1 *Sampling Device* for determining smoke density, as

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² *Annual Book of ASTM Standards*, Vol 05.01.