

TABLE 10. AVERAGE FLUE GAS DEW-POINT FOR VARIOUS FUELS²

TYPE OF FUEL	AVERAGE DEW-POINT TEMPERATURE, F
Anthracite.....	68
Semi-Bituminous Coal.....	84
Bituminous Coal.....	93
Oil.....	111
Natural Gas.....	127
Manufactured Gas.....	137
Propane Gas (2500 Btu/cu ft).....	119
Butane Gas (3200 Btu/cu ft).....	124
Butane-Air Gas Mixture (535 Btu/cu ft).....	121

Therefore, unless heating equipment is designed for operation at flue gas temperatures below the dewpoint, which is seldom the case, it is always advisable to maintain temperatures above this value in all parts of the appliance. Excessive spot temperatures in the combustion chamber or elsewhere, on the other hand, are also destructive in that they may result in rapid oxidation of ordinary heating surfaces. *American Standard Requirements* for gas furnaces, floor furnaces, and recessed heaters, for example, specify that minimum spot heating surface temperatures during normal operation must neither fall below 178 F (50 F above average dewpoint) nor exceed 875 F on any portion of the heating surface. In any event it is usually desirable to maintain flue temperatures within the limits indicated not only throughout the appliance, but in its connecting vent, flue, or chimney as well. Otherwise, excessive condensation and corrosion problems, with resultant customer dissatisfaction, will in all probability be the result. Average dewpoint temperatures of flue gases resulting from the combustion of various fuels, when burned with the amount of excess air normally supplied to insure complete combustion, are shown in Table 10.

SOOT

The deposit of soot on the flue surfaces of a boiler or heater acts as an insulating layer over the surface, and reduces the heat transmission to the water or air. The *Bureau of Mines Report of Investigations* No. 3272²³ shows that the loss of seasonal efficiency is not so great as has been believed, and usually is not over 6 percent because the greater part of the heat is transmitted through the combustion chamber surfaces. The *Bureau of Standards Report* BMS 54²⁴ points out that, although the decrease in efficiency of an oil fired boiler, due to soot deposits, is relatively small, the attendant increase in stack temperature may be considerable.

The soot accumulation clogs the flues, reduces the draft, and may prevent proper combustion. Soot can probably be most effectively removed by a jet of compressed air, by means of a brush, or a vacuum cleaner. However, it has been found that copper chloride, lead chloride, tin chloride, zinc chloride, common salt and some other salts are partially effective in removing soot from furnaces and boilers when properly used.²⁵ A discussion of instruments and methods of evaluating smoke will be found in Chapter 50.

REFERENCES

¹ Five Hundred Tests of Various Coals in Househeating Boilers (*U. S. Bureau of Mines Bulletin* No. 276).

² Combustion Efficiencies as Related to Performance of Domestic Heating Plants,

by A. P. Kratz, S. Konzo and D. W. Thompson (*University of Illinois, Engineering Experiment Station Circular* No. 44).

³ Quality of Anthracite as Prepared at Breakers, 1935 (*U. S. Bureau of Mines Report of Investigation*, R. I. 3283).

⁴ Hand Firing Soft Coal Under Power Plant Boilers (*U. S. Bureau of Mines Technical Paper* No. 80).

⁵ *Combustion Flames and Explosions of Gases*. Lewis and von Elbe (Cambridge University Press, 1938).

⁶ *Oil Burning*, by H. A. Romp (Martinus Nijhoff, 1937).

⁷ ASTM Test Designation D287-39.

⁸ ASTM Test Designation D611-43T.

⁹ Tomorrow's Fuel Oil, by W. A. Sullivan and E. B. Glendenning (*Fueloil and Oil Heat*, Vol. 4, No. 1, May 1945 p. 36).

¹⁰ The Correlation of Cetane Number with Other Physical Properties of Diesel Fuels (*Journal of the Institute of Petroleum*, Vol. 30, 1944, p. 193-197).

¹¹ Characterization of Petroleum Fractions, by K. M. Watson, E. F. Nelson and G. B. Murphy (*Industrial and Engineering Chemistry*, Vol. 27, Dec. 1935, p. 1464).

¹² Burning Index for Distillates, by J. C. Reid and A. B. Hersberger. *Fueloil and Oil Heat*, Vol. 5, No. 9, Jan. 1947, p. 90).

¹³ Carbon Hydrogen Ratio of Catalytically Cracked Distillate Fuel Oils, by S. P. Cauley and E. B. Delgass (*The Oil and Gas Journal*, Vol. 45, No. 12 July 27, 1946, p. 166).

¹⁴ Rating of Fuel Oils by a Test Unit, by D. W. Locklin and G. V. Parmelee (ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*, Dec. 1950, p. 121).

¹⁵ *Gaseous Fuels* (American Gas Association, 1948, pp. 56-59).

¹⁶ *Gas Analysis and Testing of Gaseous Materials* by V. J. Altieri (American Gas Association, First Ed. 1945).

¹⁷ Tentative Methods of Test for Specific Gravity of Gaseous Fuels (American Society for Testing Materials, ASTM Designation: 1070-49).

¹⁸ Standard Method of Test for Calorific Value of Gaseous Fuels by the Water-Flow Calorimeter (American Society for Testing Materials, ASTM Designation: 900-48).

¹⁹ American Standard for Installation of Gas Piping and Gas Appliances in Buildings. ASA Z 21.30 1950 (American Gas Association).

²⁰ NBFU Standard for the Installation of Oil Burning Equipments—NBFU pamphlet no. 31 (National Board of Fire Underwriters).

²¹ Domestic Gas Range Research (American Gas Association Laboratories Bulletin 7, p. 64).

²² Condensation of Moisture in Flues, by William R. Morgan (University of Illinois, Engineering Experiment Station Circular No. 22).

²³ Effect of Soot on Heat Transmission in Boilers (*U. S. Bureau of Mines Report of Investigation* No. 3272).

²⁴ Effect of Soot on the Rating of an Oil-Fired Heating Boiler (National Bureau of Standards Report BMS 54).

²⁵ Removal of Soot from Furnaces and Flues by the Use of Salts and Compounds, by P. Nicholls and C. W. Staples (*U. S. Bureau of Mines Bulletin* No. 360).

BIBLIOGRAPHY

Fuels and Their Combustion, by Haslam and Russell (McGraw-Hill Co., 1926).

Principles of Combustion in the Steam Boiler Furnace, by Arthur D. Pratt (Babcock and Wilcox Co.).

Smoke-Producing Tendencies in Coals of Various Ranks, by H. J. Rose and F. P. Lasseter (A.S.H.V.E. TRANSACTIONS, Vol. 45, 1939, p. 329).

Fundamentals of Combustion in Small Stokers, by C. A. Barnes (*Bituminous Coal Research, Inc., Technical Report* No. IV).

Hand-Firing of Bituminous Coal in the Home, by A. P. Kratz, J. R. Fellows, and J. C. Miles (*Illinois Engineering Experiment Station Circular* No. 46).

Classification and Selection of Illinois Coals, by G. H. Cady (*Illinois State Geological Survey Bulletin* No. 62).